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ZOOARCHEOLOGY AND BONE TECHNOLOGY FROM ARENOSA SHELTER (41VV99), LOWER PECOS REGION, TEXAS.

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by

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DISSERTATION

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Dedication

This work is dedicated to those who have shaped my intellectual development and to those who supported me through the process of researching the Arenosa Shelter faunal materials. First must come my parents, Kenneth C. Jurgens (deceased) and Evalyn K. Jurgens, who gave me examples for hard work, lifetime learning, and appreciation of the bounty of the natural environment in Texas. Jean Richmond (deceased), my junior high science teacher, provided a strong start to a broad approach to the study of biology and archaeology. Next, my undergraduate advisor in archeological studies at the University of Texas at Austin, E. Mott Davis (deceased), used the Arenosa Shelter excavations as an icon for his freshman introductory archaeology classes. He put the vision of the site as the uncut crown jewel of Lower Pecos archaeology into our thinking. In my case, the vision remained and colored my research interests for the past 30 years. Mott also encouraged me to believe in myself, to return to academia to pursue my doctorate a decade after completing my M.A., and to enjoy life and family. Samuel Wilson, my doctoral supervisor, has encouraged me, guided me, and amazed me with the breadth of his knowledge throughout this process. He also showed me how to balance work, family, marriage, academic pursuits, and life while remaining a decent person. For Ernest Lundelius (retired director of the Texas Memorial Museum-Vertebrate Paleontology Laboratory and Professor Emeritus, Department of Geosciences at the University of Texas at Austin) and Eileen Johnson (Professor of Museum Science and Curator of Anthropology, Texas Tech University Museum and Director, Lubbock Lake Landmark), I must give a heart-felt thank you for your direction and strong support. As dissertation committee members, professors, and friends who have demanded excellence and strong effort over nearly two and a half decades, you've rewarded me with friendship and insight into how faunal remains may be studied and how very different individuals conduct the process of scientific research. For the other members of my dissertation

committee, Thomas R. Hester, Michael B. Collins, and James A. Neely, thanks for your wisdom in guiding me out of the wilderness of finding a topic, through the research, and into the shelter on the river to completion. Finally and most importantly, to my wife Kathleen and to our children, Will and Hannah, who were born and have grown during my doctoral studies--I could not have finished this marathon without your support.

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ZOOARCHEOLOGY AND BONE TECHNOLOGY FROM ARENOSA SHELTER (41VV99), LOWER PECOS REGION, TEXAS.

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Research into the zooarchaeology and bone technology of the Lower Pecos cultural region provided in insight into extraction of faunal resources from the arid canyon lands of the region by its prehistoric inhabitants and how they incorporated those resources into human subsistence and technological systems. Using samples from the National Park Service held-in-trust faunal and bone artifact collections obtained from Arenosa Shelter during excavations at 1960s, the current research detailed the extensive use of faunal resources in the site and use of diverse econiches in subsistence pursuits by prehistoric inhabitants of the region. In particular, heavy reliance on resources from the rivers themselves was documented. The current research discovered specific processing methods for the

many medium to large fish caught by prehistoric inhabitants. Filleting was used prehistorically in preparing fish for consumption and raises the possibility of both long-term storage and transport of food products away from the rivers and canyons themselves. Also encountered in the faunal study was a specific skinning method used prehistorically to remove whole pelts, preserving the distinctive features of the head. Presence of this method, termed caping, raises the possibility of pelt use for shamanistic purposes and may have implications for connections to the region's prominent rock art. More typical was the documentation of fauna-related subsistence pursuits with a heavy reliance on rabbits, artiodactyls, and certain other terrestrial animals from late Pleistocene to Historic times. Detailed butchering sequences were determined from the analysis. From those pursuits, subsistence byproducts entered the technological system as input for bone technology subsystem operating in parallel to and in support of subsystems based on other raw materials. Detailed analysis of manufacturing and use wear characteristics was conducted using a large sample of the bone artifacts from Arenosa Shelter. The analysis enabled the prehistoric manufacturing process for bone implements and ornaments to be defined. The use wear component was the first of its kind in this region and documented use of implements in support of subsistence, textile, lithic, and other segments of the technological system over a significant time period.

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I. CONTEXT OF RESEARCH

Chapter 1: Introduction

PROLOGUE

During the terminal Pleistocene and early Holocene, the natural and cultural environment on the southern margin of the North American Great Plains changed significantly (Bement 1986; Johnson 1986, 1987). Extinction of large herd mammals during the terminal Pleistocene removed all megafauna as potential Paleoindian quarry except the bison. Availability of bison varied during the Late Quaternary in response to greater seasonality and increased annual temperature fluctuations (Dillehay 1974; Lundelius, *et al*. 1987; Johnson and Holliday 1989, 1995; McDonald 1984).

Apparent in the archaeological record from sites in the region, including Aubrey, Baker Cave, Blackwater Draw, Bonfire Shelter, Devils Mouth; Hinds Cave, Lipscomb, Lubbock Lake, Miami, Plainview, and Wilson–Leonard, is an apparent shift by later Paleoindians from a concentration on megafauna hunting to hunting, trapping, or collecting a wider variety of smaller game (Bousman, *et al*. 2002; Collins 1995, 1998; Dibble and Lorrain 1968; Ferring 2001; Hester 1983; Hofman, *et al*. 1991; Holliday, *et al*. 1994; Hulbert 1984; Johnson 1964; Johnson and Holliday 1989; Johnson 1987; Lord 1984; Lorrain 1965; Saunders 1980; Saunders and Daeschler 1994; Sellards, *et al*. 1947; Sorrow 1968). Available evidence supports Late Paleoindian hunters responding to environmental change at the Pleistocene – Holocene transition by adopting initial aspects of a broad-spectrum hunting and gathering Archaic lifeway, actively hunting or scavenging large prey opportunistically only when it was available (Bousman, *et al*. 2002; Collins 1998; Johnson 1964; Johnson 1987; Sorrow 1968; Vierra 1994). Broad resource procurement was evident in Baker Cave deposits of this context, with an established fiber industry apparent (Andrews and Adovasio 1980; Hester 1983).

Despite episodes of increasing aridity in the early Holocene over much of the region and the evident shift in several aspects of human technology, long-term stability is apparent in the regional archaeological record of the Archaic cultural stage throughout most of the Holocene (Dering 1999; Hudler 2000:88-91; Toomey 1993:450). Subsistence and tool-making technologies may have been altered during the Early Archaic in response to region-wide changes in the natural environment, but thereafter achieved a stability that lasted with minor variations to within 1,000 years of the present time. A wide, but changing array of plant and animal resources obtainable by hunter-gatherer subsistence technologies has been available during the last 12,000 years on the southern Great Plains and at its margins (Dering 1999; Hudler 2000; Johnson 1987; Toomey 1993).

Episodic aridity in the early Holocene partitioned the landscape of the Southern Great Plains into relatively dry uplands bisected by a series of better-watered riparian corridors (Figure 1). This was especially true in the Lower Pecos cultural region of Texas and northern Mexico, located at the southern margin of the Great Plains (Bryant and Holloway 1985; Dering 1999; McMahan, *et al*. 1984; Trimble 1980:Fig. 1). Riparian corridors formed oases in the midst of a desert-adapted shrub-shortgrass savannah. The shrub-shortgrass savannah had a component of desert succulent vegetation that became more pronounced as the Holocene progressed, although this trend may have been reversed by at least one strong mesic interval (Dering 1999).

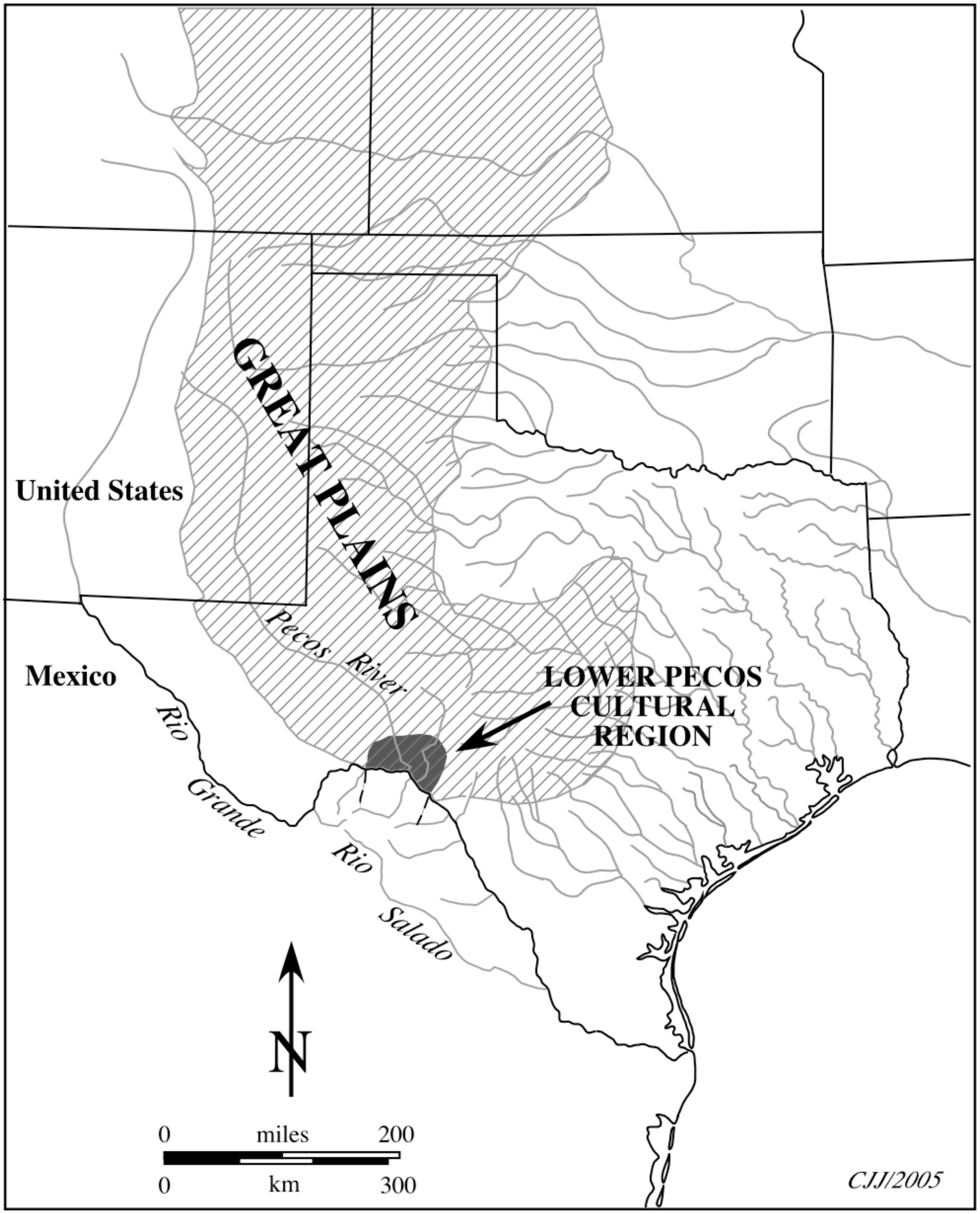

Figure 1: Location of Lower Pecos Cultural Region on southern margin of Great Plains physiographic region.

Four vegetation units have been identified for the Holocene Lower Pecos region on the basis of modern analogues and plant fossils, broadly grouped into upland and lowland zones by Dering (1979), Flyr (1966), and Lord (1984). These units include the vega-terrace unit found on riparian canyon floors, the cliff-canyon unit in the middle and upper portions of tributary canyons, upland hills, and upland flats (Lord 1984:45-48). The canyon units are distinguished on the basis of water needs of woody vegetation. Large trees have been present on the vega-terraces in the past, including mesquite, willow, sycamore, pecan, live oak, and mulberry. Other constituents have included the common reed, and several species of *Opuntia* sp. cacti. Large trees in the Rio Grande-Pecos canyons are susceptible to destructive effects of flooding which removes them from the landscape for several decades (Williams-Dean 1978). Similar effects from flooding may be documented on prehistoric settlement in the region.

Hunter-gatherers living permanently in the Lower Pecos oasis focused on critical natural resources, especially permanent water sources. Subsistence technologies aided successful adaptation of hunter-gatherers to the Lower Pecos oasis and surrounding arid lands, allowing available prey to be extracted from all environmental zones.

INTRODUCTION OF RESEARCH PROBLEMS

Hunter-gatherer subsistence technology may be split into several behavioral components. Among these are procurement (tools or food), processing (tool-making or processing of foodstuffs), and use/storage (tools, foodstuffs, etc.). Procurement of foodstuffs may be differentiated by the nature of prey. Plants and animals have much different procurement and processing requirements, with differing implications for hunter-gatherers (Speth 1990, 1991a). Both provide carbohydrates, proteins, fats, and trace minerals necessary in the human diet.

The pursuit and capture of many animals represents more of a risk because they are mobile. This risk may be lessened through adequate knowledge of a specific prey's behavior and habitat preferences that reduces the total area searched for them (Bettinger 1991; Winterhalder 1986). One important generalization understood by both the hunter-gatherer and the anthropological analyst is that animal foods also provide large amounts of complete protein and fat, two critical nutrients lacking in many plants foods. These are variable, but usually seasonally predictable and reliable. Fish often have higher fat levels than most terrestrial vertebrates, an important consideration in a riparian oasis. Fat and protein content in fish vary seasonally individually and within a species, as do the overall condition and amount of meat and roe (McClane 1981:3, 7; Speth 1990, 1991a).

Bone may be fashioned into formal or informal tools through a variety of manufacturing techniques, including dynamic fracturing (analogous to flaking of lithic tools) using hammer stones or grooving and snapping. Further shaping during manufacturing or rejuvenation is possible by flaking, grinding, and other abrasion (Harrell 1983; Johnson 1985). Tools may be used in many ways, including but not limited to cutting, scraping, puncturing, and punching.

Bone may have offered Lower Pecos hunter-gatherers an acceptable alternative material to wood, shell, and cryptocrystalline stone for producing usable tools or tool components that would have been used in active or passive hunting and fishing, butchering, net-making, hide processing, lithic tool-making or many other activities in their daily lives. Long-term bone preservation in archaeological and paleontological localities in the region is often quite good, so evidence for manufacture and use of bone tools is identifiable and available in the form of finished tools and manufacturing debris.

The intent of the dissertation research was to determine what vertebrate animal resources Late Quaternary resident of the Lower Pecos region took from the environment, how they used it for subsistence purposes, and how they incorporated byproducts from subsistence into a sub-set of the technology system. By examining the hunting and fishing technology used in the Lower Pecos region, the author determined how prehistoric hunter-gatherers gained, processed, possibly stored, used foodstuffs and gained the means necessary to cope with both stability and variability in the environment (Croes and Hackenberger 1988). Inferences are drawn from these coping mechanisms may have affected individual or group decisions, such as cooperative behaviors, such as those relating to technology, ritual, etc. (Chartkoff 1989:291).

Specific research questions used in the dissertation research to examine aspects of Lower Pecos subsistence technology included:

1. Did Lower Pecos residents use much of the landscape to obtain the faunal portion of their subsistence economy?
2. How much use of faunal resources from the canyons and surrounding arid uplands did Lower Pecos indigenous residents make and did they fully process carcasses for food and other products?
3. Did prehistoric Lower Pecos indigenous inhabitants tap the resources of the rivers and fully use the available fish for subsistence and technological purposes?
4. Were specific techniques used by Lower Pecos indigenous peoples, such as caping, to skin medium sized mammals for purposes other than standard subsistence needs?
5. By the Middle Archaic, did Lower Pecos indigenous peoples use faunal resources for purposes beyond fulfilling subsistence needs and incorporate their byproducts to fulfill technological needs?

6. Did prehistoric Lower Pecos indigenous inhabitants exploit the byproducts of subsistence in specific ways for raw materials that were incorporated into the technological subsystem?
7. Were decorative elements incorporated into their technological pursuits by prehistoric Lower Pecos inhabitants?
8. Did prehistoric residents of the Lower Pecos region use bone technology for the purposes of supporting other segments of the overall technological system?

SUMMARY OF THE PROJECT

The dissertation project began with background research into methods and theory of subsistence technology and the archaeology of the Lower Pecos cultural region. The background research was especially directed to determine how they related to Arenosa Shelter (site 41VV99), a site with a large, diverse, but incompletely studied faunal collection and abundant evidence of bone technology. Also included in the background research was a thorough examination of existing field and laboratory records for Arenosa Shelter. From the results of background research, the theoretical orientation and methodology for data collection, analysis, and interpretation were developed for the current project.

The project used two parallel lines of investigation to examine Lower Pecos subsistence technology. One was a study of the Arenosa Shelter faunal collection that included residues from the inhabitants' subsistence economy. The second was a study of bone technology, using artifacts from the site to determine how bone tools and ornaments were manufactured and used in the technological system in a region where many other durable raw materials for tools were limited.

The two studies occurred sequentially, beginning with the faunal analysis. A sample of complete or fragmentary animal bones was drawn from Arenosa Shelter faunal specimens housed in the Texas Memorial Museum's Vertebrate Paleontology Laboratory (TMM-VPL) collections. Following museum preparation of the sample, data were collected using microscopic examination to identify taxonomic characteristics and cultural modifications. The bone technology analysis was the second step in the sequence. A sample of specimens was taken from the bone artifacts in the collections of the Texas Archeological Research Laboratory at the University of Texas at Austin. Following museum preparation of the sample, data were collected using low to high-power microscopic examination to identify manufacturing and use wear characteristics. The results from both studies were analyzed and compared to results anticipated from the theoretical framework.

SCOPE OF THE PROJECT

Reassessing initial intentions to study Paleoindian subsistence technology, the current research was decided upon because it involved a similar theoretical perspective using an important, but incompletely studied, collection from the Lower Pecos region. A major consideration involved in choosing the current research subject was that all collections from Arenosa Shelter were housed in Austin, where the author's family resided and where he had full-time employment. Choosing to study the Arenosa Shelter materials provided access to a faunal collection of over 47,000 complete or fragmentary late Quaternary faunal specimens and nearly 1,000 Middle Archaic to Late Prehistoric – Historic bone artifacts from Arenosa Shelter. The complex nature of the site's stratigraphy, its physiographic location, recovery methods used by the excavators, the effects of long term museum storage, and current physical state of the records and collections themselves all affected the data available to research. It was known early in the investigation that the research would provide a detailed look at an incomplete sample of remains from Lower Pecos subsistence technology. However, both of these large and diverse collections had sufficient bone preservation to make research results a major contribution to the study of Lower Pecos archaeology.

During this research project, data from 547 bone artifacts and approximately 4,900 faunal specimens were collected in FileMaker Pro databases and analyzed. Included in the faunal sample were the plaster-jacketed Late Pleistocene bison remains from Feature 18 that were excavated under laboratory conditions prior to its analysis. The stratigraphy of Arenosa Shelter was carefully re-examined to determine taphonomic factors that caused reduced frequency and deteriorated condition of faunal and bone artifact materials from lower strata, including Feature 18. Based directly on Dibble's original field notes, profiles, and photographs, rather than subsequently published but incomplete descriptions, the refined definition of lower strata more completely reflects the complicated stratigraphy in the area specifically studied for the current research. The faunal analysis resulted in identification of approximately 140 taxa from this diverse assemblage that was dominated by rabbits, deer, catfish, and cyprinid suckers. Terminal Late Archaic faunal specimens dominated the sample and originated in upper strata that were the site's least disturbed. The flood ravaged Early Archaic strata provided very few faunal specimens. Specific outcomes of prehistoric processing of prey carcasses were identified, including specialized skinning behaviors for carnivores and filleting of fish.

Analysis of 547 bone artifacts from Middle Archaic to Late Prehistoric – Historic context resulted in definition of 40 forms of ornaments and 29 forms of implements based on morphology and manufacturing characteristics. Bead forms constituted the ornament class. Implements included a wide array of formal and informal forms that were dominated by elongated, tapering spatulates. Manufacturing byproducts and stages were also identified during the investigation. Analysis of manufacturing characteristics identified a range in complexity in both tools and ornaments. Artifact forms varied from simple tools or ornaments that were based on minimally modified skeletal elements to formal tools or ornament with extensive raw material modification during manufacture. Incised decoration was found on a limited number of both tools and ornaments. Most implements were made from extensively modified deer or antelope long bones, while a more diverse array of mammals and bird long bones provided raw materials for beads. Wear characteristics were also used to tentatively identify what implements were used for.

STRUCTURE OF THE DISSERTATION

The dissertation structure is comprised of eight chapters grouped into three major sections and four appendices. The major sections include: Context of Research; Current Research, Analysis, and Results; and Interpretation. The initial section contains three chapters. The first chapter is introductory. It introduces research problems, summarizes the project and its scope, and introduces the structure of this study. The second chapter places the research into regional archaeological context. The theoretical and methodological context of the work is contained in the third chapter. The second section of the dissertation contains three chapters that are the central to the work. Chapter Four puts forth the methods and materials used in the current research. The next two chapters describe the results of the faunal and bone artifact analyses. Final chapters of the dissertation are grouped into the third section and interpret the results of the research. Chapter Seven discusses subsistence evidence, bone modification, and special topics that include specific skinning behaviors used in obtaining carnivore hides and interpretation of the Late Pleistocene bison carcass in Feature 18. The final chapter presents a summary of the research, its eight conclusions, and suggests avenues for further research. Appendix 1 contains tables from Chapter Two. Tables from Chapter Five are contained in Appendix Two and relate to results of the faunal analysis. The third appendix contains tables from Chapter Six, the bone artifact analysis results. The final appendix contains four tables from Chapter Seven that synopsize the context of research at Arenosa Shelter and regional chronology, compare diachronic degree of fragmentation for aggregated groups of taxa, and interpret Feature 18.

Chapter 2: Arenosa Shelter and the Lower Pecos Archaeological Record

Arenosa Shelter was recorded as an archaeological site in 1958. Graham and Davis (1958) located the site during preliminary archaeological survey of the proposed Diablo Reservoir in Val Verde County, southwestern Texas. Diablo Reservoir was later renamed Amistad Reservoir in the spirit of friendliness and cooperation hoped for along the international boundary between the United States and Mexico (Figure 2). The site was designated with the triniomial number 41VV99 in the River Basin Survey site numbering system used by the Smithsonian Institution's program for archaeology. The trinomial designation indicates the ninety-ninth site recorded in the county of Val Verde (VV) in Texas (state designator 41).

Arenosa Shelter was originally recorded as a terrace site exposed in gully cutbanks and terrace scarps dissecting the river terrace below the canyon wall. The rock shelter was recognized after testing at the site began (Prewitt 1997). Only when the brush and tree cover was removed was it determined that the site was a rock shelter almost completely filled with alluvial and cultural deposits.

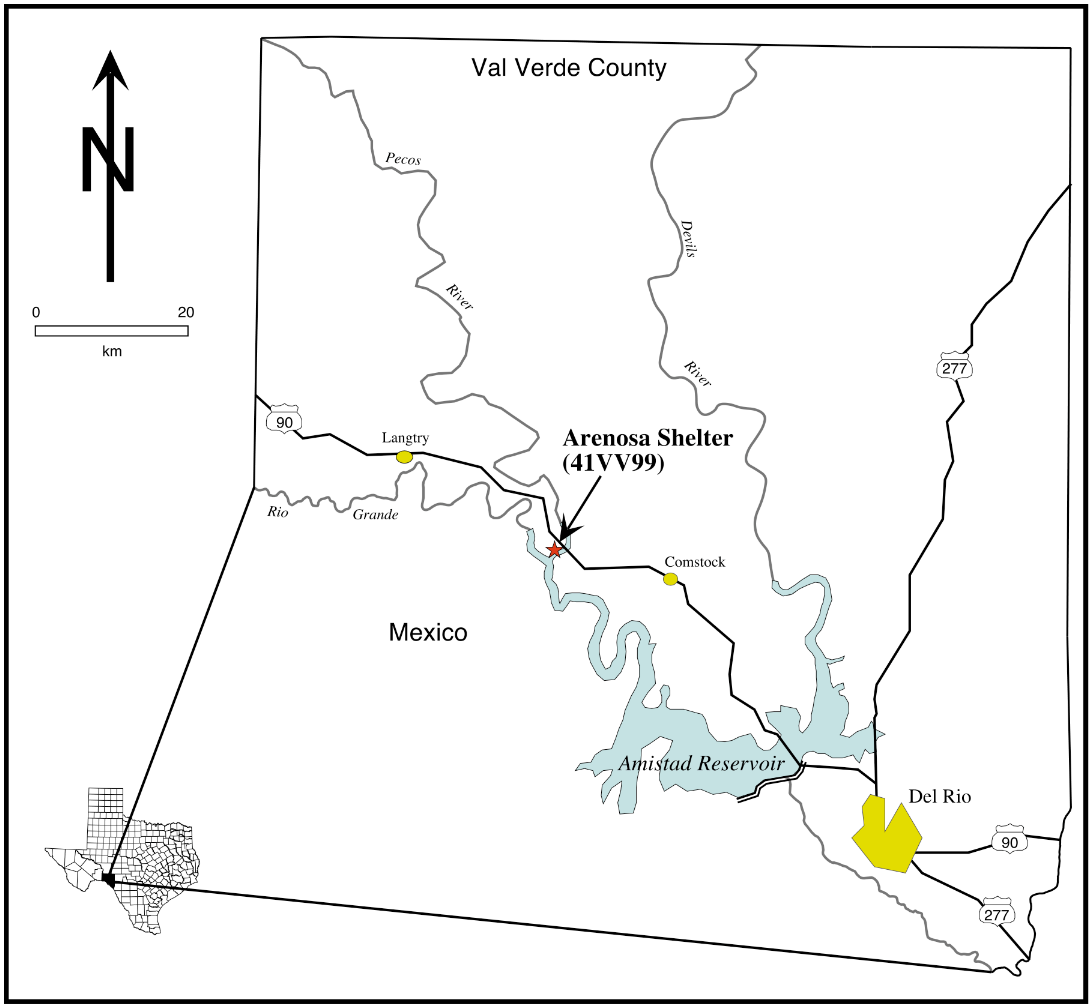

Figure 2: Schematized location of Arenosa Shelter (Site 41VV99) within the Lower Pecos Cultural Area.

CHRONOLOGY AND CULTURAL POSITION

Arenosa Shelter's cultural sequence was uniquely important to the excavator (Patton and Dibble 1982:106). He stressed that it represented an essentially continuous occupation in the upper part of the Amistad Reservoir area over the last 10,000 years of cultural development in the region. The unique sequence existed because the lower deposits in the rock shelter were protected from Pecos River floodwaters. A large roof block partially blocking the shelter entrance and an alluvial fan immediately upstream of the shelter both deflected much of the destructive force of floodwaters away from the site.

Researchers over the last three decades segmented the Lower Pecos cultural sequence according to their own needs (Collins 1974; Dibble personal communication to Prewitt cited in Prewitt 1983; Shafer 1986; Story and Bryant 1966; Turpin 1991). The current research uses a chronology based on Dibble's phase names as period designations with durations reported by Turpin (1991). The chronology is in Table 2.1.

There are recognized problems with the natural and typologically-based cultural stratigraphy from Arenosa Shelter. But, as Dibble firmly believed, it remains very important. The excavations produced over 32 ^{14}C assays that yielded a chronological sequence of at least 9,550 radiocarbon years. The published ^{14}C assays in Table 2.2 are abstracted from Patton and Dibble (1982) and Turpin (1991:Table 1.1).

Most of the chronological sequence is from the Archaic cultural stage. The earliest ^{14}C date from Arenosa Shelter was from charcoal in stratum 38 near the base of the depositional sequence (Patton and Dibble 1982:106; Turpin 1991:24-25). Like many of the other lower strata in the shelter, stratum 38 is partially flood-disturbed. Stratum 38 contains burned rock, charcoal, and lithic artifacts that are the earliest unequivocal cultural materials in the site (Collins 1974:549). This stratum is below the first identified Early Archaic cultural materials (Early Barbed-style projectile points).

An undated bison carcass was recorded by Dibble (n.d.) as Feature 18 in stratum 40. His field notes associated the disarticulated partial carcass in Feature 18 with two limestone cobbles and a single small chert flake. These associations were in a fine textured stratum devoid of other cobbles. Vertebrate paleontologist Rickard Toomey tentatively identified the Feature 18 carcass as *Bison antiquus*, an extinct late Pleistocene species of bison. Undated, scattered fragments of bison and other large ungulates were recorded in stratum 42 and included *Bison antiquus* long bone fragments recorded as Feature 19, the oldest cultural feature found. Features 18 and 19 were deposited between the end of the Paleoindian Bonfire period and the beginning of the Oriente period.

Many researchers would recognize late Paleoindian-aged cultural remains in the Lower Pecos region as Archaic (Turpin 1991:24-25). They meld a Paleoindian lithic tradition into a subsistence technology with broad-spectrum resource procurement and fiber industry technology. Research reported from Baker Cave and Hinds Cave supports this view (Andrews and Adovasio 1980; Hester 1983; Shafer 1986). Late Paleoindian evidence in the Lower Pecos is very similar to that reported for the Paleoindian Western Pluvial Lakes tradition in the Great Basin, rather than the big-game hunting association typically associated with the southern Great Plains (Hester 1973; Willig, *et al.* 1988).

The end of the Lower Pecos Archaic was marked by a technological change about 1,000 years ago when the bow and arrow was adopted (Bement 1989; Turpin 1991:26-35). Between 8,800 years ago and about 1,300 years ago, the archaeological record is dominated by a stable broad-spectrum subsistence technology. Subsistence primarily utilized starches from desert succulent plants as a major staple food source in an episodically arid environment (Brown 1991; Chadderdon 1983; Dering 1999; Shafer 1981, 1988; Shafer and Bryant 1977; Sobolik 1991, 1996; Stock 1983; Turpin 1988; Williams-Dean 1978).

The Lower Pecos Early Archaic is the Viejo period. Typological nomenclature is still evolving for over-lapping projectile point forms during this 3,400-year period between 8,800 and 5,500 years before present (B.P.). Forms include Early Barbed, Early Stemmed, and Early Corner Notched. Typology of the Early Barbed forms has been refined to define the *Baker* and *Bandy* types in the Lower Pecos. These are similar to the *Uvalde* and *Martindale* types of central and southern Texas.

Well-adapted Early Archaic hunter-gatherers occupied Arenosa Shelter during the Viejo period (strata 37 - 33) that intensified their broad-spectrum subsistence technologies in response to environment changes. Feature types known from the region include burned rock middens, hearths, and prickly pear pad-floored living areas (Lord 1984). Earth ovens were first used to cook desert succulents such as lechugilla, prickly pear cactus, and sotol during the Viejo periods. Evidence for them is found from the latest part of the archeological record for the Viejo period at Baker Cave and Hinds Cave (Brown 1991; Dering 1999; Shafer and Bryant 1977). Williams-Dean (1978) and Stock (1983) analyzed coprolites from Hinds Cave dating to this period. The human fecal matter analyzed by Williams-Dean (1978) dated to about 6,000 years B. P. She found the remnants of a diet that included gathered plants (desert succulents such as prickly pear, sotol, and lechugilla; nuts; and wild onions) rodents, birds, and reptiles. Stock (1983) analyzed slightly earlier coprolites to compare with the Williams-Dean (1978) data. Her analysis found prickly pear, wild onion, walnuts, persimmons, fish and rodents.

Between 6,000 and 5,000 years B.P., projectile points change typologically and technologically to Middle Archaic styles, including *Pandale*. The gradual post-Pleistocene regional drying trend prior to 5,000 B. P. was occasionally punctuated by hot-xeric or cool-mesic intervals, but had an overall reduction in effective moisture and increase in seasonality (Blum, *et al.* 1994:14; Dering 1999; Hall 1990; Toomey 1993:450). Arenosa Shelter's depositional records (strata 32 - 30) contain erosional disconformities caused by floods at the beginning of the Middle Archaic. Intense erosion in the region and major flood events disturbed many of the lower strata at Arenosa Shelter. Ten major flood events affected the site during the latter half of the period from 5,500 to 3,200 B.P. (Collins 1974:547-556; Dering 1999; Patton and Dibble 1982).

Cultural deposits in Arenosa Shelter's lower strata are significantly disturbed by flooding and often not in primary context between strata 30 and 36 (Dibble n.d.).

The post-glacial minimum in effective moisture occurred between 5,000 and 2,500 B. P. (Blum, *et al*. 1994:14-15; Toomey 1993). Increased summer insolation and other factors favored greater monsoonal flow during the early Holocene. Isolated high intensity convectional storms first occurred during this period. A concurrent reduction in vegetation allowed soil profiles degradation and erosion across the Edwards Plateau, including at its southwestern margin in the Lower Pecos. Deep, overbank flood events were rare for Edwards Plateau streams in the Early Holocene (Blum, *et al*. 1994: 16). The sedimentary response to climatic change in the Lower Pecos region itself differed in timing from streams on the Edwards Plateau proper (Blum and Valastro 1989:450-451; Kochel 1988; Kochel and Baker 1988; Kochel, *et al*. 1982; Patton and Baker 1977; Patton and Dibble 1982; Patton, *et al*. 1979).

The cultural response to increasing aridity during the early Middle Archaic was an increased population density in the canyons. This increase was accompanied by regional insularity in projectile point styles during the first millennium of the Eagle's Nest period, 5,500 - 4,500 B.P. (Hester 1980; Turpin 1991:28-29). Lord (1984:212-213) found that deer were the primary meat animal in the diet during the Archaic at Hinds Cave, supplemented by smaller mammals before about 4,800 B. P. and after 4,000. B. P. After 4,800 B. P., fish and aquatic turtles were also important supplements. Dering (1999) and Brown (1991) consider the use of labor-intensive earth oven cooking technology to cook desert succulents an indication that dietary stress caused less desirable plant resources to be used during prolonged seasonal drought. Dering (1999), based on experimental evidence, considers earth ovens for processing desert succulents to indicate forced reliance on foods that required adoption of a high degree of residential mobility because fuel and desert succulents are quickly depleted. Mussel shells from the rivers occurred in many of the Archaic strata at Arenosa Shelter (Collins 1974:547-556). Periodic, more intense flooding during this time exposed higher quality chert sources in river gravels often buried within the thick alluvium in stream valleys (Collins 1974:390-395). Regionally, fluvial deposition restarted about 5,000 years ago and allowed alluvial terraces to accrete (Blum and Valastro 1989; Blum, *et al.* 1994; Hall 1990).

At Arenosa Shelter (strata 21 - 23), the trend in regionally insular projectile point development continues in the San Felipe period (4,100 - 3,200 B.P.). Refinement and differentiation on the *Pandale* technological theme led to development of the *Langtry, Val Verde, Almagre*, and *Arenosa* types. Population density and episodic environmental deterioration are two factors possibly relating to the introduction of ritual rock art in the region during this period (Turpin 1990). The Lower Pecos region is situated in a gradational zone between the Great Plains and Chihuahuan Desert and experiences an extreme variation in annual and seasonal rainfall (Boyd 2003; Dering 1999).

The early part of the Late Archaic (Cibola period, 3,150 - 2,300 B.P.) had a moister climate regime. Plains grass species recolonized the upland desert grasslands and the major protein and fat resources in bison returned to the region. An economic shift towards hunting of bison is shown by widespread occurrence of broad-bladed, barbed projectile points, e.g. *Marcos* and *Marcos*-like (Dibble, as cited Turpin 1991:31). *B. bison* remains from this time period are known from Arenosa Shelter (strata 10 and 11). A widely held view is that these *B. bison* remains and associated projectile points may represent the intrusion of Plains groups (Turpin 1991:31).

The latter two Late Archaic sub-periods (Flanders, 2,300 B.P. and Blue Hills, 2,300 - 1,300 B.P.) have both typological and stratigraphic problems, which make interpretation of their remains at Arenosa Shelter difficult (Turpin 1991:32-34). These include dating inconsistencies in strata 9 and 10 that contain *Shumla*-like projectile points. Possible mixing of strata containing *Ensor* - *Frio*-type projectile points between Strata 2 and 9 in the site is another problem. Both overall continuity and some variation in technique in the lithic technology through time occur in these strata at Arenosa Shelter (Collins 1974:356-360). Differences in use of soft hammer bifacial thinning support evidence for the possible intrusion of Plains bison hunters during the Late Archaic.

The Late Prehistoric cultural stage is represented at Arenosa Shelter by the Flecha and Infierno periods, 1,320 - 450 B.P. (Turpin 1991:35-36). A change in subsistence technology is documented when the bow and arrow was adopted at the beginning of the period. Arrow points co-occur with *Ensor* dart points in mixed context in Arenosa Shelter (Stratum 2a). It is difficult to properly sequence the chronology of arrow point types for similar reasons (Turpin 1991:35-36). Economic strategies, mortuary patterns, and rock art change during the period. Ring middens consistently appear to date to this or later time periods. The results of recent work by Kenmotsu and Wade (2002) and Mehalchick and Boyd (1999) consider the Infierno cultural manifestation to be a local variant of Toyah groups residing elsewhere on the Edwards Plateau.

Coprolites from the Late Prehistoric occupations at Baker Cave contained dietary remnants rich in plants and small animals (Sobolik 1991). The principal plant was the prickly pear cactus, although desert succulents were also eaten as a staple. Wild onions were used as a seasoning or relish (Sobolik 1991:109). Seeds from cacti, goosefoot, juniper, and hackberry, oak acorns, and walnuts were also part of the plant foods consumed. Fish were the most important faunal constituent of the diet. Cyprinform and perciform fish bones and scales were associated with charcoal. This co-occurrence is attributed to roasting of whole fish prior to consumption (Sobolik 1991:110). Small mammals included cotton rat, woodrat, and deer mouse. Recovery of nearly all bones of single individuals of these species in individual Baker Cave coprolites indicated that small mammals were being ingested nearly whole (Sobolik 1991:110). Small birds were also being eaten whole. Lizard bones and skin, snake vertebrae and scales, and rabbit bones in coporolites also occur in Baker Cave coprolites. Larger animal remains were not contained in the Late Prehistoric Baker Cave coprolites because meat was removed from their bones before it was eaten (Sobolik (1991:110, 115).

A lack of many material remains from the Historic period other than rock art panels is evident (Boyd 2003; Turpin 1991). Historic rock art includes post-contact motifs such as missions, crosses, cattle, robed figures, and men on horseback (Boyd:2003:21, Figure 2.7). Historic period indigenous rock art has early and late styles (Kenmotsu and Wade 2002:119-121). The late art is drawn in naturalistic Plains Ceremonial and Biographic style, possibly reflecting intrusion of Comanche or Kiowa Apache into the region (Kenmotsu and Wade 2002:121-122; Keyser 1987:45-48). Stone structural remains are reported from Historic Period sites and include wickiup or tipi rings, small cairns, and mortar holes (Kenmotsu and Wade 2002:117; Mehalchick and Boyd 1999:157).

SITE DESCRIPTION

Arenosa Shelter is described based on excavations made before its 1969 inundation by Amistad Reservoir. Site 41VV99 is a rock shelter on the right-hand (northwest) bank of the Pecos River, 1.2 km above its confluence with the Rio Grande (Figure 3). Kochel (1980), Patton (1977), Patton and Dibble (1982:108) reported that its location is within the conservation pool of Amistad Reservoir (Figure 4). Before dam construction, it was on the outside of a meander of the Pecos just above its Rio Grande confluence (Figure 5).

The shelter opens in a southeasterly direction and had a horizontal extent of over 95 meters. The excavated area of the site was at least 14 meters deep (Collins 1974:35; Dibble 1967). The alluvial fan at the mouth of a short tributary canyon extends onto the alluvial terrace about 100 meters upstream of the site. The fan protects the site's deposits from the direct impact of all but the largest floods from upriver. The tributary canyon extends about 1.5 km into the uplands west of the Pecos River. Surrounding uplands rise at least 100 meters above the floor of the Pecos river canyon.

Figure 3: View of Arenosa Shelter (Site 41VV99) excavations in progress from up-river, noting proximity of Pecos River and canyon wall.

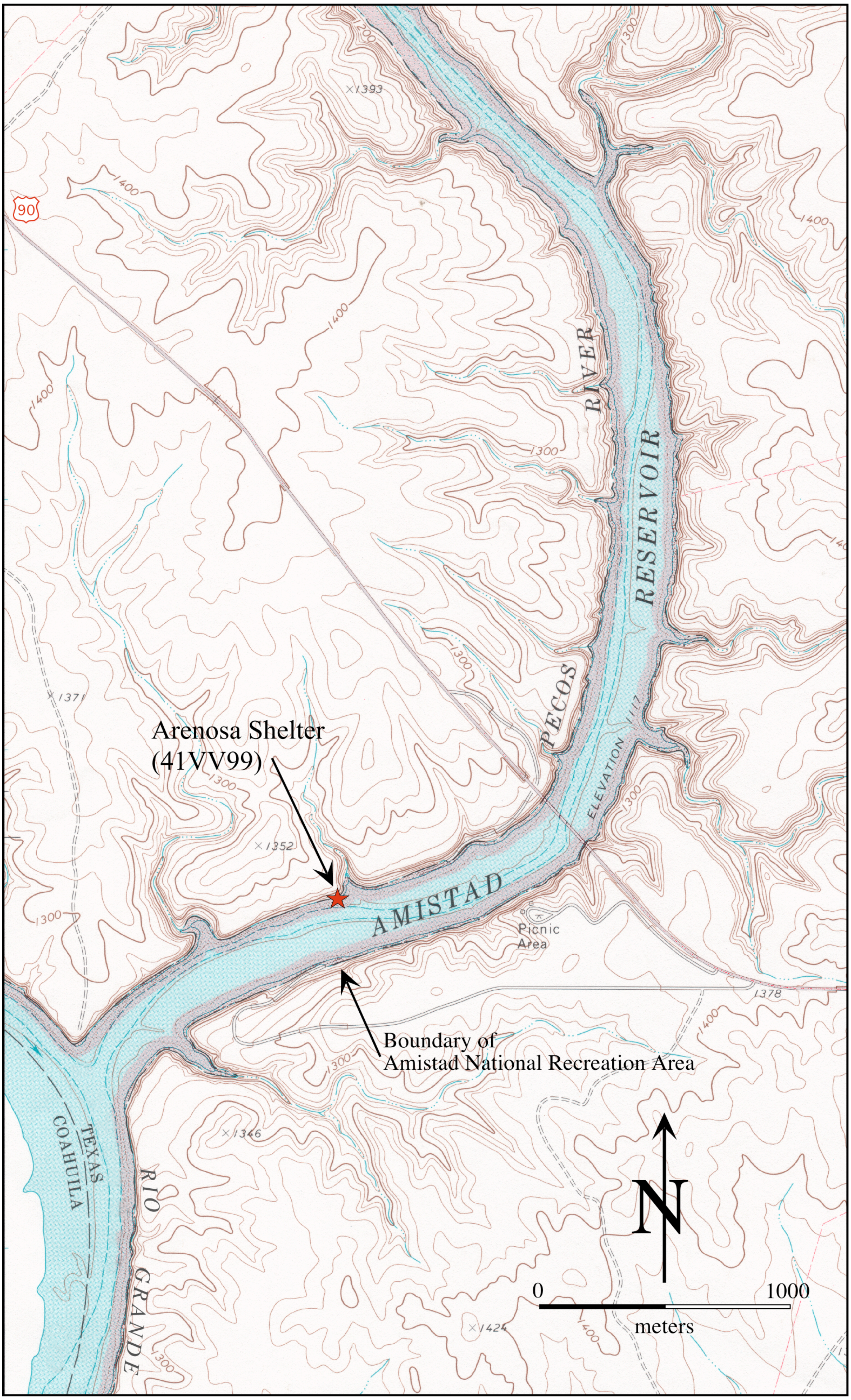

Figure 4: Location of Arenosa Shelter within conservation pool of Amistad Reservoir and Amistad National Recreation Area as plotted on 1972 U. S. Geological Survey Seminole Canyon quadrangle.

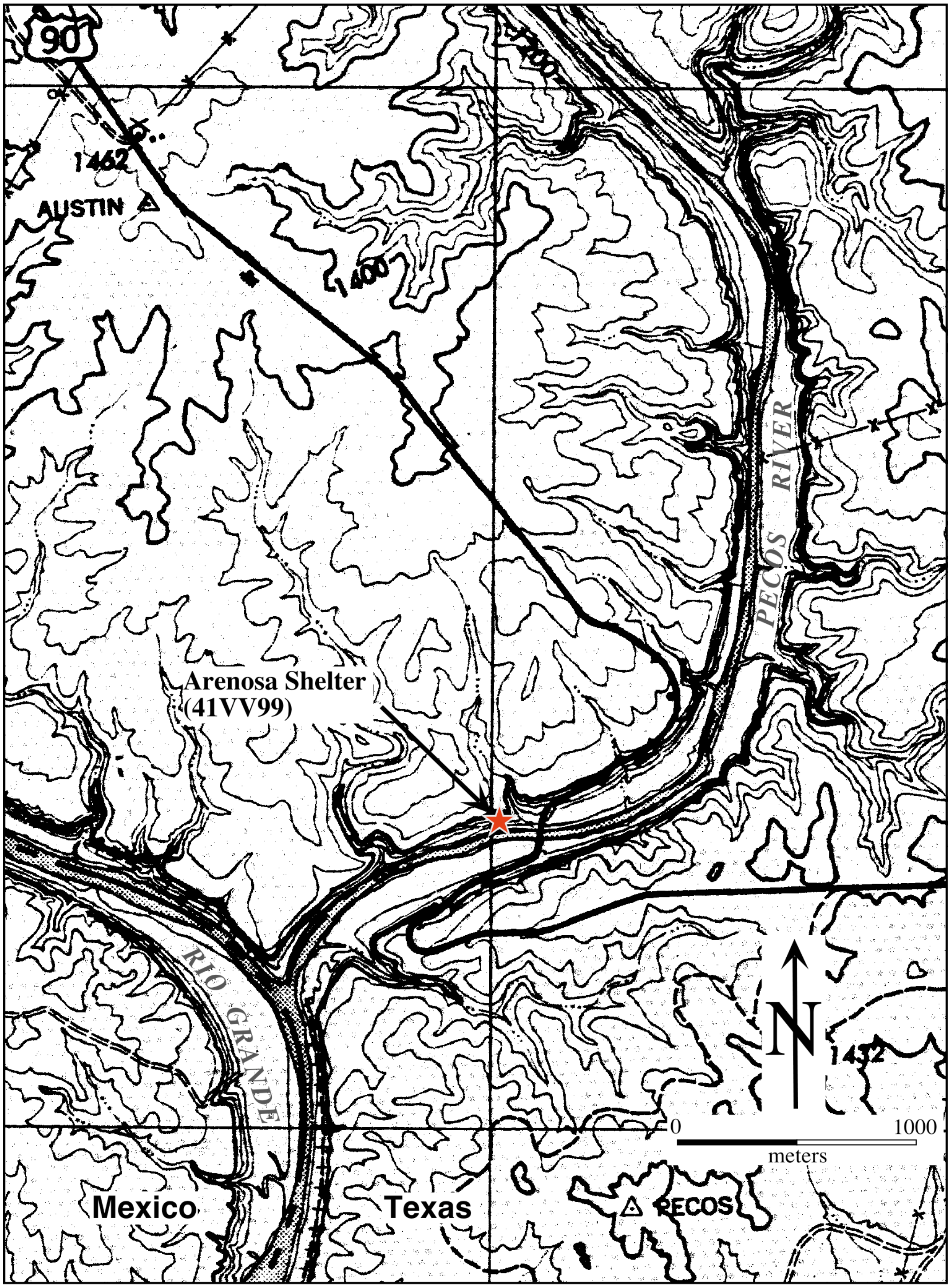

Figure 5: Recorded location of Arenosa Shelter on outside of last meander of Pecos River before Rio Grande confluence as plotted on 1944 U.S. Army Mouth of Pecos 15-minute quadrangle.

The site's topographic setting is important because it lies low on the canyon wall. The site is at the topographic boundary between the alluvial terraces of the Pecos River and the lower canyon wall at an elevation of approximately 329 meters (1080 ft) above mean sea level (U. S. Army 1944). The site is contained in the first and second alluvial terraces (Dibble 1967:4; Kochel 1980; Patton 1977; Patton and Dibble 1982). The topographic setting is important in stratigraphic interpretation because it shows primary characteristics of open alluvial terrace sites and secondary characteristics of rock shelters. A large, distinctive notch that forms a pour-off point for runoff draining down the steep slope marks the bedrock of the lower canyon wall just above the site.

As excavated, Arenosa Shelter's deposits were between 6 and 21 meters above the natural, low water surface of the Pecos. As shown in Figure 6, the site contained stratified cultural materials, features, and living floors in a sequence that almost completely filled the shelter (Collins 1974:35; Kochel 1980; Patton 1977; Patton and Dibble 1982:Figure 5). The stratigraphic sequence also contained inter-bedded, culturally sterile limestone fragments, alluvial sands, and silts. Context of cultural materials in most upper strata was good except where mixing was documented. Some lower strata were adversely affected by flooding. Cultural materials in strata 32-36 were redeposited and in secondary context. The largest of several large limestone spalls and roof blocks that fell during the shelter's early occupation blocked the shelter's mouth in the lower deposits.

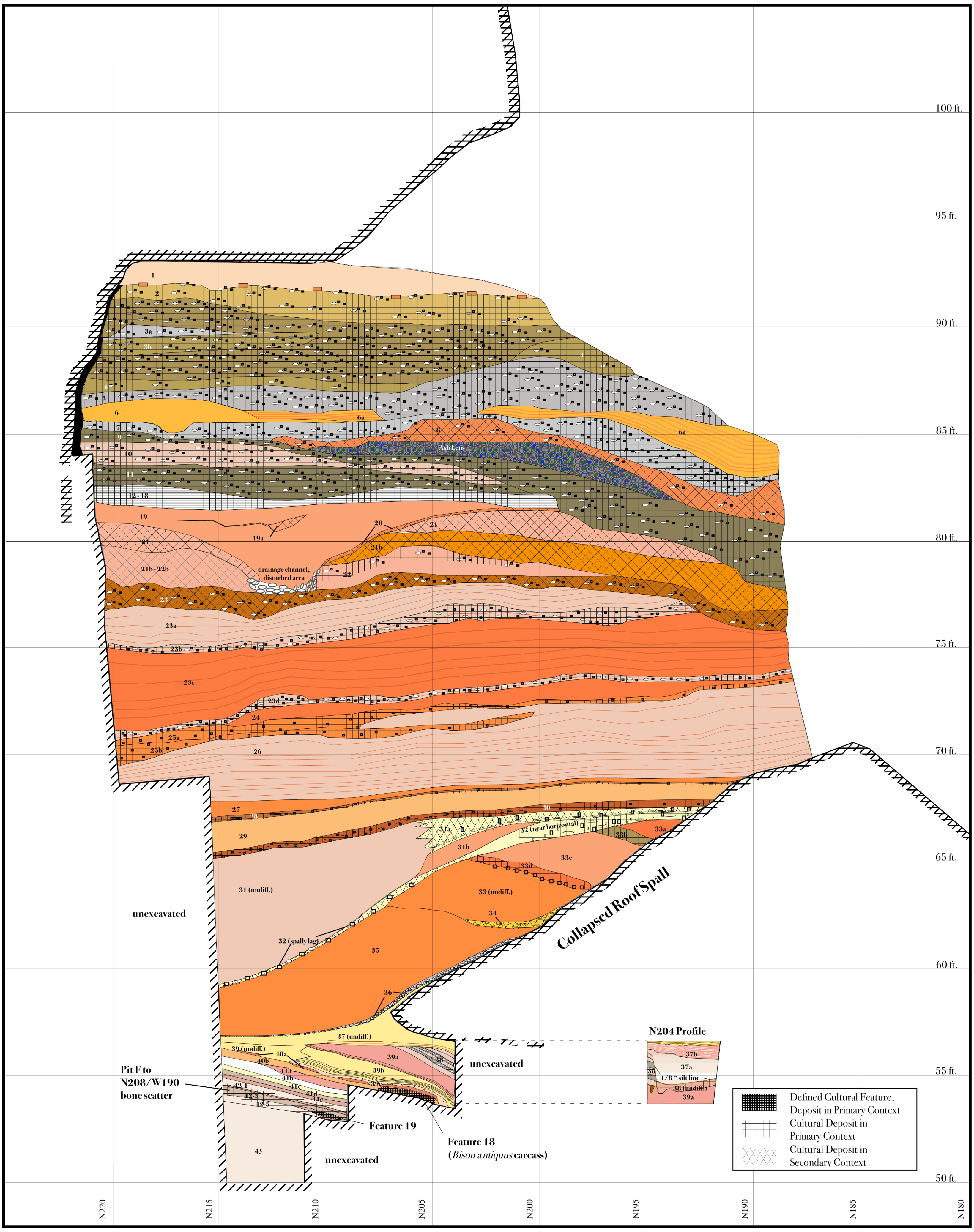

Figure 6: Profile of stratigraphy of Arenosa Shelter (Site 41VV99) along W165 – W170 grid line on upstream end of site.

Named the “Big Mother Rock” by the excavation crew, this spall was at least 15.17 meters long, 13.14 meters wide, and 5.5 meters thick and had formed part of the overhanging roof of the shelter before its fall (Dibble, n.d.). The lowest deposits excavated at the site were composed of limestone dust, small limestone spalls, and sands.

The excavated late Quaternary depositional sequence at Arenosa was at least 48 feet (14.5 meters) thick and consisted of 49 defined strata. Twenty four strata contained cultural materials in either primary or redeposited context (Collins 1974:547; Dibble n.d.). Stratigraphic descriptions found in Tables 2.3 and 2.4 and Figure 6 are based on the excavator's field notes and published sources. The descriptions for strata 1- 22 are based on those in Dibble (n.d., 1997) and Collins (1974). Descriptions for strata 23 - 42 are based solely on Dibble's original field notes, profiles, and photographs, rather than subsequently published but incomplete descriptions. These sources more completely illustrate the complicated stratigraphy in the area specifically studied for the current dissertation. The more detailed description is critical in interpretation of the site's basal deposits and their faunal contents.

HISTORY OF PREVIOUS RESEARCH

This research uses National Park Service (NPS) collections resulting from major salvage excavations sponsored by the NPS at Arenosa Shelter. Excavation of the site occurred during planning and construction of Amistad Reservoir. Prior to its inundation in 1969, the site was excavated in four field seasons between 1965 and 1968 by University of Texas at Austin crews. Crews from the Texas Archeological Salvage Project (TASP) worked under the field direction of David S. Dibble (Prewitt 1997:ix-x).

Dibble excavated the site in two large blocks, with a standard grid overlaid to control horizontal provenience (Collins 1974:548-549). The grid's N-S axis was oriented to about 330° East of North to align with the bluff and terrace orientation along the river (Figure 7). Two N-S backhoe trenches cut perpendicular to the bluff bounded the down stream excavation block. A third N-S trench was excavated about 50 feet upstream. Excavation unit size was based on 5x5 foot squares, but small individual units were sometimes combined into larger aggregated units (e.g. 10 x 15 feet).

Dibble's excavation strategy was to cut two initial trenches, designated Trenches 1 and 2, perpendicular to the bluff in areas where disturbance to site deposits were evident. The location of the eastern trench (Trench 2) enabled use of an existing surface gully below the pour-off notch. Trenches 1 and 2 were about 23 feet apart. They delimited the initial block and provided stratigraphic profiles for the excavation. The block delimited was squared on the river side by a third backhoe trench (Trench 3) that also provided an excellent, connecting stratigraphic profile. A third large block was later excavated immediately east of the first backhoe trench. Two additional backhoe trenches (4 and 5) were also excavated. The areas excavated in each field season are shown in Figures 8 – 10.

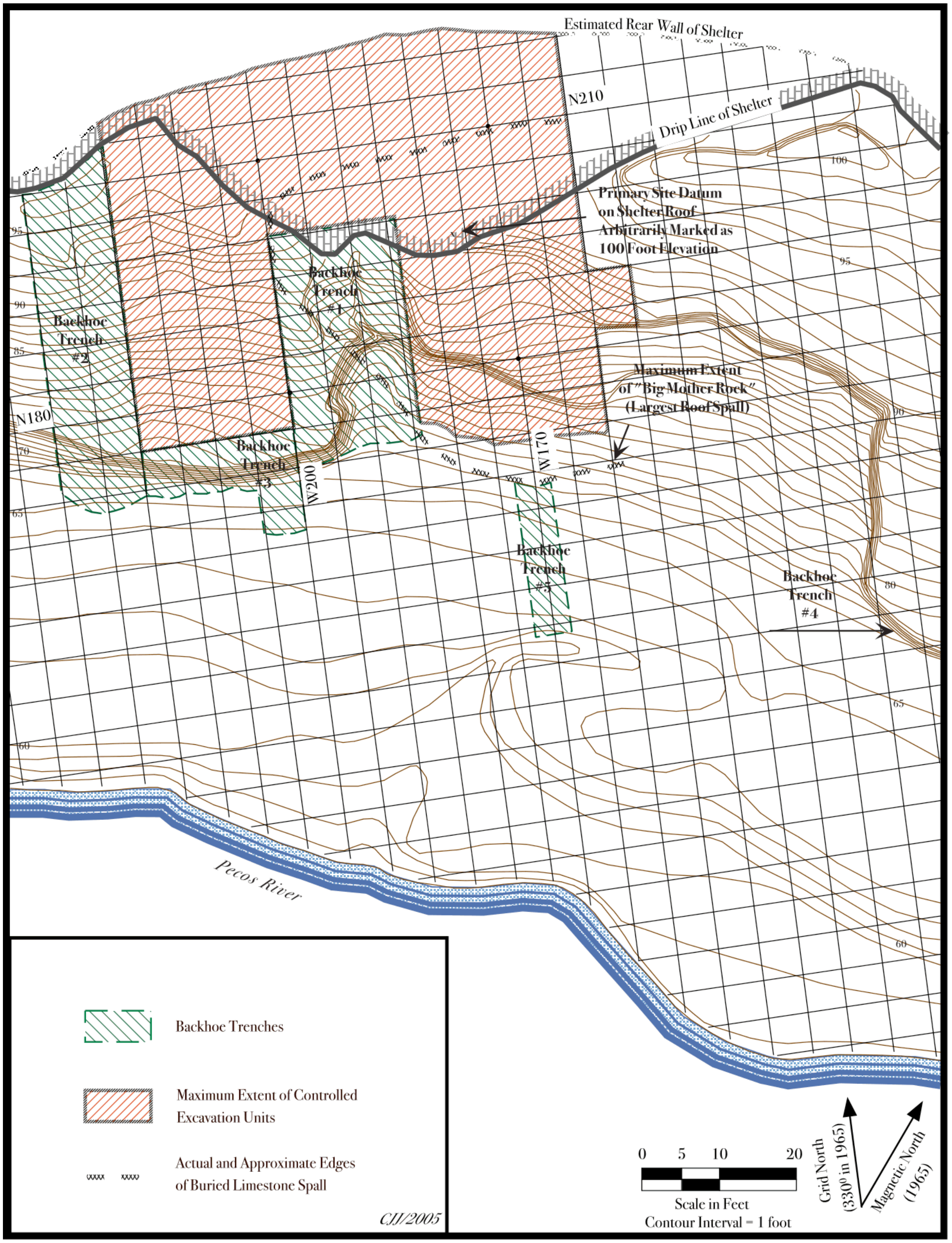

Figure 7: Overall plan of 1965 – 68 excavations at Arenosa Shelter (41VV99), including locations of controlled excavation units and backhoe trenches.

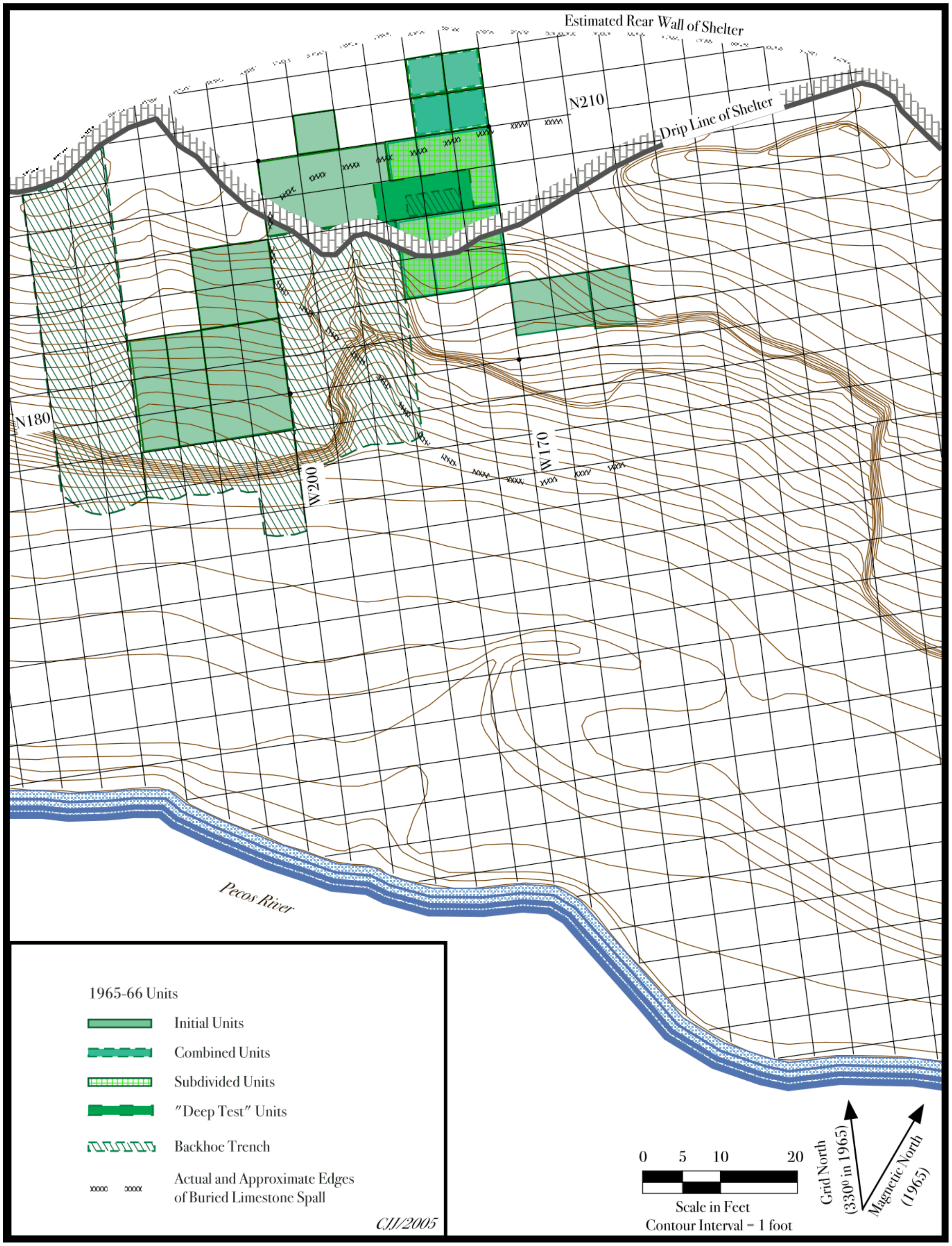

Figure 8: Extent of excavations in 1965-66 Field Season at Arenosa Shelter (41VV99).

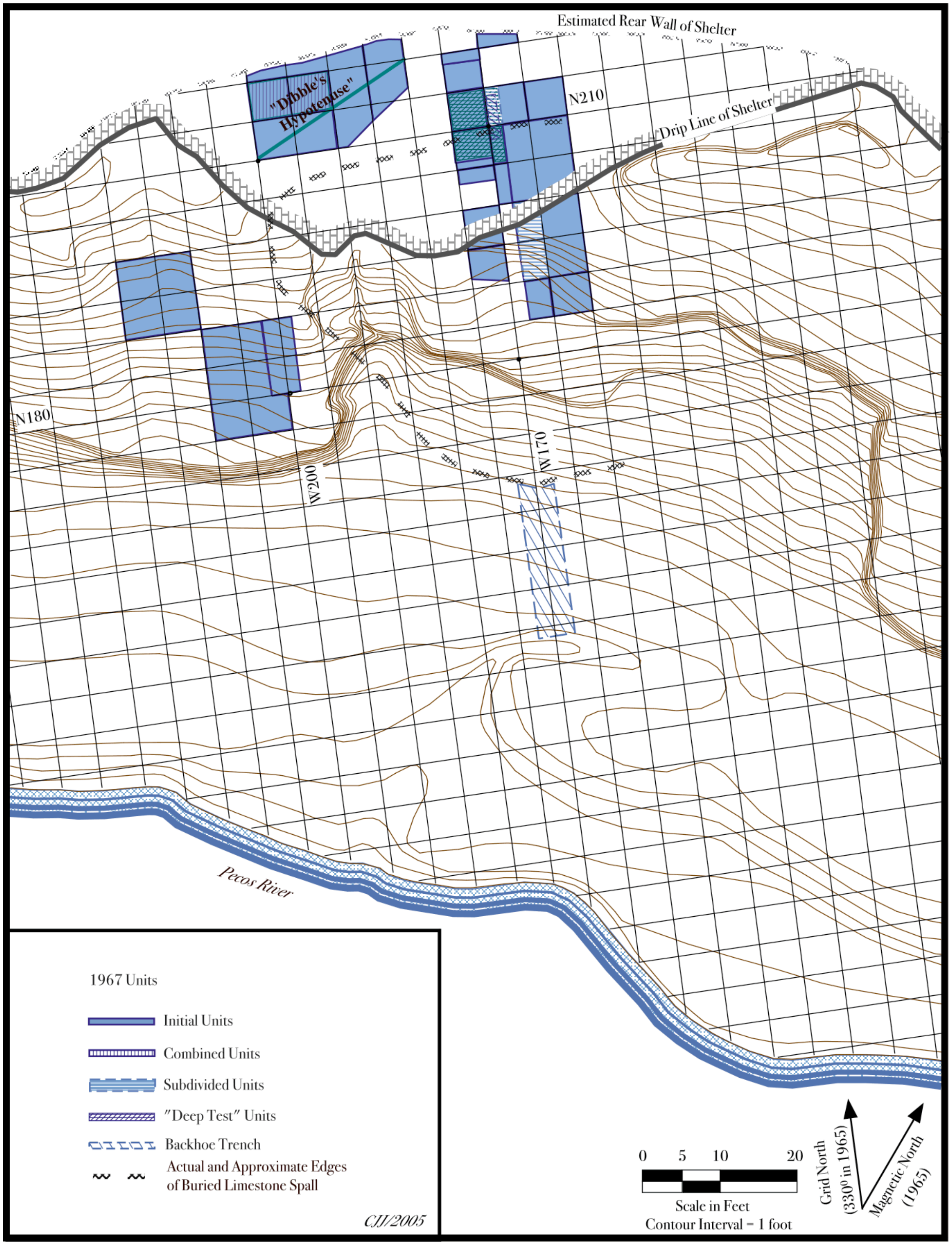

Figure 9: Extent of excavations in 1967 Field Season at Arenosa Shelter (41VV99).

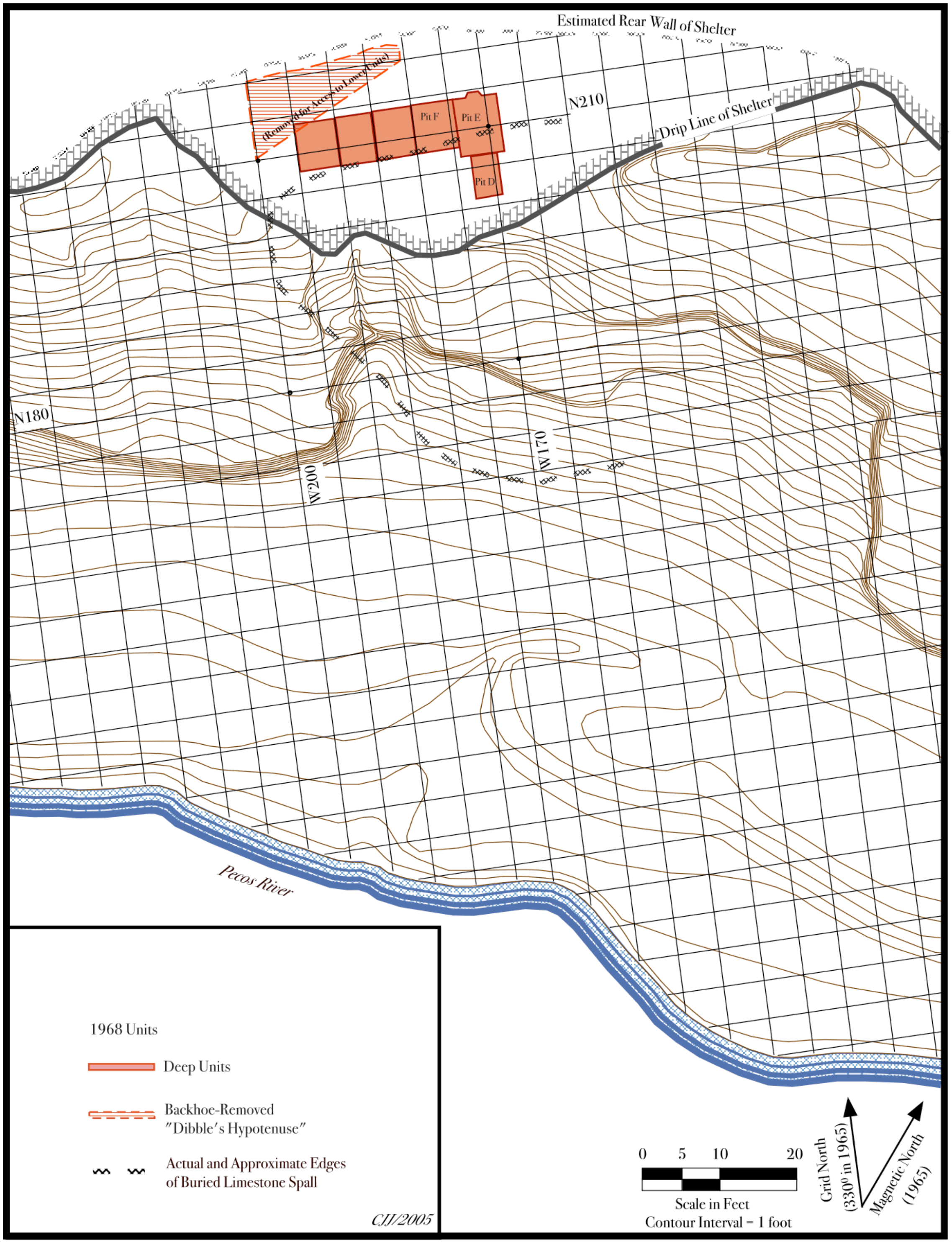

Figure 10: Extent of excavations in 1968 Field Season at Arenosa Shelter (Site 41VV99).

Excavation of individual controlled units totaled about 1460 ft^2. Dibble and his assistants excavated downward from the initial surface by working back from the profiles exposed in the trenches. Excavation was by natural strata. Thicker strata were subdivided into several arbitrary levels, termed “cuts,” which dipped with the strata (Dibble 1967:9; M. B. Collins, March, 1995:personal communication). All material from controlled excavation units was manually screened. Most screens used 0.25-inch mesh hardware cloth. The initial 1965-66 field season used the 0.5-inch mesh size that was also commonly in use at the time (E. R. Prewitt, May, 1996:personal communication). Material recovered from each stratum within an excavation unit was grouped into about 750 numerically designated lots for cataloging and future analysis. No final report on the excavations had been written by the time of Dibble’s death in 1993. In 1997, the Texas Archeological Research Laboratory (TARL) reprinted the interim report submitted to the NPS in 1967.

Field records indicated that Dibble designated 404 of the approximately 750 total lots as containing bone. The current research sampled faunal materials from the upstream end of the site containing the deepest deposits. It also sampled previously cataloged bone artifacts. Selection of the sample area allowed analysis of faunal materials from 85 lots, or about 20 per cent of the lots with bone, and included a large portion of lots with the best bone preservation, most stringent recovery methods, and most accurate provenience.

The 440 ft^2 study area was located east of Trench #2 and included materials between Stratum 1 and Stratum 37 in the excavation block between N200/W160 and N210/W180. Faunal material from Stratum 38 - 42 in the deepest parts excavated in the site was also included in the current analysis. This lower zone included all areas excavated between N199/W167 and N215/W195, including Pits D, E, and F, and the 5x8 ft^2 units N208/W180 - N208/W190. Based on preliminary tallies from previous cataloguing efforts, approximately 3,250 bone fragments were represented in the sample. These represented about 7 percent of the total bone fragments from the site at the time that analysis began. A revised estimate of bone fragments based on the current analysis is presented in Chapter 4.

The collections from Arenosa Shelter are curated in two research laboratories at The University of Texas at Austin and have been differentiated on the basis of their contents. Field excavation and lab records, bulk samples, and excavated cultural artifacts are curated at TARL, including previously recognized bone tools. Bio-artifactual faunal materials were transferred to the Vertebrate Paleontology Laboratory of the Texas Memorial Museum (TMM-VP) in the 1980s. These TARL and TMM-VP collections were re-inventoried in the late 1980s, aided by a NPS grant for collections originating at Amistad National Recreation Area. The re-inventory results were entered into the NPS computerized database as part of the subset designated AMIS for Amistad. The NPS database is designated the Automated National Catalog System II (ANCS II). This effort re-inventoried approximately 56% of the 400+ lots from the excavations, including bone artifacts and bone fragments. Many of the over 8,700 the ANCS II database entries for Arenosa Shelter cultural materials represent single items. The database included 1,348 entries for bone fragments and bone artifacts at the beginning of the current research, totaling over 47,000 individual items.

The TMM-VP collection received additional examination under a National Science Foundation (NSF) collections management grant in the early 1990s. This NSF grant funded a more complete analysis of faunal material in 88 of the lots, including 38 that were not examined during the NPS re-inventory by TARL. This analysis results were entered into the TMM-VP permanent computerized specimen catalog. The databases resulting from these studies were not intended to be the results of full-scale analysis.

Collins (1974:581) researched the lithic technology of Arenosa Shelter in his dissertation and reports 1,541 projectile points in Arenosa Shelter site collections. His research occurred soon after the completion of field work. Complete projectile points include previously defined Archaic and Late Prehistoric types (See Table 2.5). There are also several untyped cataloged forms that include early lanceolate and parallel-flaked styles. Lithic artifacts and debitage are abundant in the site collections at TARL, with 973 entries in the AMIS catalog for projectile points (n=1,256). Many of these are multiple-specimen entries. Additionally, many other entries in the TARL database catalog identify items as bifaces that are recognized specifically as projectile point fragments or preforms.

The typological classifications in the Arenosa Shelter AMIS catalog are broad and may be internally inconsistent (Turpin 1991:18). Provenience information in the catalog does not account for the horizontal and vertical variation across the site or divisions in its strata. The original excavator recognized this discrepancy and cautioned that stratigraphic designations were not always equivalent to cultural levels across the site (Dibble 1989: personal communication to Turpin cited in Turpin 1991).

The only detailed typological study on projectile points from Arenosa Shelter reported a statistical analysis of the three Middle Archaic *Langtry*-type variants (n=101) from the shelter (Bement 1991). These include concave-based contracting stemmed (*Langtry*), convex based contracting stemmed (Variant 3), and expanding stemmed (*Val Verde*) forms. The analysis showed that all three are statistically valid types. Bement (1991:62) proposes recognition of the Variant 3 form first documented by Schuetz (1956) as a distinct, formal type under the name *Arenosa*.

Two Ph.D. students of University of Texas at Austin geology professor Victor Baker conducted dissertation research using Arenosa Shelter. This research was conducted in the mid- to late 1970s and used Arenosa Shelter data. The research concentrated on the site's stratigraphic record and was assisted by Dibble. These dissertations by Robert C. Kochel (1980) and Peter C. Patton (1977) investigated paleo-flood hydrology, its reflection in the stratigraphic record, and the effect of those earlier floods on the region's stratigraphic record.

ASSESSMENT OF RESEARCH POTENTIAL AND TAPHONOMY

Considerable effort was spent in the present research locating and identifying all relevant notes, photos, drawings, and plans now available from the 1965-68 excavations. The field excavation records in the possession of TARL constitute most of those originally produced by Dibble and his associates. My conclusion is based on examination of relevant collections and associated records, and through supplementary interviews with persons directly involved with the excavations or who conducted research using the collections over the last three decades (M. B. Collins, E. R. Prewitt, and S. A. Turpin). Some original profile drawings and plane table maps, and most color slides are no longer accessible at The University of Texas at Austin. They were either lost in the field, were misplaced in the laboratory, or passed from possession of either TASP or TARL after field work was completed. Dibble returned records in his possession when he left University employment in the early 1980s. The missing sources may have been overlooked when Dibble left or they may remain at TARL in an unforeseen location.

Records in TARL's possession duplicate each other. Copies made by the Records Section overlap original records formerly in Sponsored Projects (formerly TASP). The original records were combined with those in the Records Section after a mid-1990s union of these research units. Elton Prewitt's cooperation clarified additional details of both field and lab records. Prewitt directed the excavation crew during the last field season and also assisted in the lab. Michael B. Collins was also intimately familiar with the TASP's 1960s work in the Lower Pecos, the specifics of Arenosa Shelter, its excavation history, and contents of its records and collections. The present study has, by necessity, been based on the Arenosa Shelter records and collections in the late 1990s.

Bone preservation of specimens in the TARL and TMM-VP collections ranges from poor to excellent. As an example, the partial *Bison antiquus* remains from Feature 18 are poorly preserved while many of the small rodent bones from strata higher in the site are in excellent condition. Abundant deer antler was found in Late Archaic levels in the site (Collins 1974:347-349). The TARL collections contain at least one modified *Odocoileus* sp. antler hypothesized to represent part of the flint-knapping toolkit (Collins 1974:129-130). Bone beads are also quite abundant, with 204 identified in preliminary analyses by Dibble and catalogued in the AMIS catalog. Additional grooved and snapped bone fragments are also coded in the AMIS catalog. Several hundred items were coded in the 1980s re-inventory as awls or awl fragments, some with distinctive wear patterns.

The site contains abundant mussel shells and bones of ducks, fish, and turtles. These are evidence of the abundant aquatic vertebrate and invertebrate resources from the region's rivers being used. Many of the fish bones were earlier identified as the remains of economically useful species, including the freshwater drum, alligator gar, and several species of large catfish.

Recovery methods used at the site were not specifically developed to take maximum advantage of faunal materials present. Variable bone preservation is evident between strata. Storage of recovered faunal materials and bone artifacts prior to museum preparation has not been climate controlled. Considering each of these issues, the current research potential of the collection is less than it potentially was at the onset of excavations in 1965. However, the site's faunal and bone technology collection remains one of the most complete in the region.

Several literature sources report that this site has been affected by complex natural and cultural phenomena during the past eleven millennia (cf. Collins 1974; Kochel 1980; Patton 1977; Patton and Dibble 1982; Turpin 1991). The effect impacted the integrity of its cultural deposits. Flooding during the early Holocene (5,500 - 3,200 B.P.) disturbed or discontinuously removed deposits from the earlier deposits (strata 30 - 36). Ten major floods affected the site during the latter half of this period (Collins 1974:547-556; Patton and Dibble 1982). The current research reinforced this interpretation. The reanalysis of records for portions of the lower strata (strata 23 - 42) determined that published descriptions significantly understated the magnitude of disturbance (cf. Figure 6). The greater disturbance in lower deposits is at least partly explained by their location within the alluvial first terrace, fully within the reach of major flooding. Above this elevation, deposits are within the reach of only the most intense floods, such as that produced in 1954 by Hurricane Alice.

Cultural reworking that incorporated overlying ash and charcoal into sterile flood deposits is another identified source of disturbance to integrity of cultural deposits. Mixing resulted in sterile alluvial deposits that graded upwards into ash deposits definitely cultural (Patton and Dibble 1982:108). The mixing may have masked individual flood events and oversimplified the complicated stratigraphy (Patton 1977:121). After preliminary analysis of field records for the 1965 - 68 field seasons and the computerized artifact catalogs, it was obvious that taphonomic factors causing differential bone preservation and frequencies must be accounted for in the current research.

Documented high-energy floods originated in the Pecos drainage and had typically yellowish, buff, or tan-colored sands. Lower energy flood events originated in the Rio Grande drainage are also present in the Arenosa Shelter depositional record. They are red mud drapes that represent slackwater flooding (Kochel 1980:73, 106, 114-116; Patton 1977:122, 185-186; Patton and Dibble 1982:108). Pecos flood events at Arenosa Shelter are unique because they exhibit reverse grading of sediments. Pecos flood events also begin with a mud drape that then gives way to laminated or ripple-stratified sands, the opposite of typical fining-upward flood sequences. Geologists attribute reverse grading to the site's location in a slackwater zone early in flood events or to the higher concentration of wash and suspended load that precedes the hydrographic peak (Kochel 1980; Patton 1977; Patton and Dibble 1982).

Chapter 3: Method and Theory

THEORETICAL BASIS FOR THE ARENOSA SHELTER STUDY

The current faunal material and bone technology research was conducted using a theoretical orientation from zooarchaeology. This orientation is based on the development and use of middle range theory in archaeology, including its subfield of zooarchaeology. Middle range theory relies on actualistic research into site formation processes, behavioral archaeology, and ethnoarchaeology (Bettinger 1991:77-82; Gifford-Gonzales 1991; Gould 1978; Kroll and Price 1991:310; Schiffer 1976; Thomas 1971, 1986). Actualistic research uses observations of modern phenomena to create a framework within which to interpret the remains of past cultures contained in archaeological collections (Bettinger 1991:61-2; Binford 1977:6; Grayson 1986; Raab and Goodyear 1984). Ethnographic observations of hunter-gatherer cultural behaviors and the material residues of those behaviors are included.

In addition to potential incorporation of bone into the technological system as a raw material, other aspects of recent zooarchaeological research are pertinent to the current study. These are studies of bone modifications occurring during carcass processing that include skinning, butchering (dismemberment and meat removal), marrow removal, bone grease production, and disposal. An overview of the development of zooarchaeological method and theory follows, with special emphasis to carcass processing and disposal aspects.

ANTHROPOLOGICAL PERSPECTIVE IN ZOOARCHAEOLOGY

Zooarchaeological analyses have approached the subject from anthropological perspectives that are both archaeological and ethnographic, as well as one more clearly paleontological. The paleontological perspective is more often termed archaeozoology (Reitz and Wing 1999:3). Both vertebrate and invertebrate remains are usually included in modern archaeological analyses of faunal materials. Some use the term osteoarchaeology to refer to the archaeological study of vertebrate osteological remains (Olsen and Olsen 1981; Reed 1963; Reitz and Wing 1999; Uerpmann 1973:22).

The scope of zooarchaeological research may vary widely, depending on the nature of the faunal remains, archaeological deposits, and the research orientation, training, and research biases of the analysts involved (Reitz and Wing 1999:4). Zooarchaeological studies in the past have investigated the physical constituents of animal bodies, byproducts, and the remains of parasites present. Anthropological faunal studies have been used to investigate site formation, biological processes, and cultural processes (Reitz and Wing 1999:6-7). The anthropological perspective reflects the complex interaction between humans and their environment. The consequences of that relationship are also included in zooarchaeology.

The human – environmental interaction may exhibit aspects of cultural change or stasis. Explaining those characteristics is complicated by the interaction itself (Reitz and Wing 1999:7). The uses to which humans put animals and their physical constituents and the diverse ways by which those constituents enter the archaeological record are part of what Reed (1963) termed the "cultural filter." This filter is a specialized aspect in the study of taphonomy, the transition of organic matter from faunal remains through its history of post-mortem, pre-burial, and post-burial changes to incorporation in the geological record (Hesse and Wapnish 1985; Lyman 1994a:1-3, Figure 2.5; Meadow 1981).

The ways culture has affected faunal material in archaeological sites and its recovery are subject to zooarchaeological study. Lyman (1994a:4) distinguishes two types of fossil faunas from archaeological sites: archaeofaunas spatially associated with cultural materials, and paleontological faunas that are not. This is the major research emphasis of the past two decades (Avery 1984, Binford 1981, Potts 1984, Turner 1984).

Modern cultural behavior affects the taphonomic process through excavation techniques and analytical strategies selected for use by the analyst, including theoretical orientation. This analytical behavior subjects the archaeofaunal record to biases that can be documented (Andrews and Cook 1985; Clark, *et al*. 1967; Hesse and Wapnish 1985; Hill 1978; Meadow 1981).

Historical Development of Zooarchaeological Method and Theory

Zooarchaeology has evolved under multiple anthropological theories most concerned with the relationship between human culture and the environment. Three most common during the latter twentieth century have been most influential (Reitz and Wing 1999:13). Theoretical orientations prevalent in the early part of the twentieth century limited faunal research contributions to lists of animals found in sites.

Under more recent anthropological theories, zooarchaeology has examined the relationship between human culture and the environment. Cultural ecology, ecological anthropology, and historical ecology have allowed full realization that this relationship is dynamic and may result in significant changes to behaviors or institutions (Bates and Lees 1996; Bogucki 1988; Butzer 1990; Clarke 1972; Ellen 1982; Geertz 1963; Jochim 1979, 1981:3-4; Moran 1990; Reitz and Wing 1999:14-15; Steward 1955; Vayda and Rappaport 1968; Winterhalder 1994; Winterhalder and Smith 1992). Recent use of post-processualist theory has brought into play perspectives that examine human behavior in terms of native meaning, especially the critical role that animals play in human culture (Hesse 1995; Hodder 1982, 1990; Leone and Potter 1988; Ryan and Crabtree 1995).

Bone's role in explanations of culture has changed considerably. Clason (1973, 1986) notes that early Swiss researchers influenced later zooarchaeologists. Eaton (1898) provided unquantified species lists, but also much more complete description and interpretation of data on butchering and faunal distribution. Loomis and Young (1912) quantified numbers of individuals in species lists and described the species recovered. They hypothesized about dietary importance based on frequency and butchering pattern data, inferred seasonality, described modified remains, and distinguished between cultural and natural occurrences of species. Wyman (1868a, 1868b, 1875) voiced early concerns about improving analytical approaches, echoing the concerns of Lartet (cf. Clermont 1994) who demonstrated the value of including small animals in studies.

The concern of most early North American archaeologists in culture history prevented advancement of zooarchaeological method and theory and found animal remains to be insignificant (Barker 1985:4; Reitz and Wing 1999:18). Animal remains from archaeological sites were studied more adequately elsewhere in the world. Most of the resulting literature was published in biological literature, e.g. Wintemberg (1919), Hargrave (1938), and van Giffen (cf. Clason 1983, 1986). These studies reported human association with extinct animals (Eddy and Jinks 1935; Miller 1929a, 1929b). Biological researchers working with North American archaeofaunas reviewed aspects of the materials that included ecosystems, descriptions of the physical remains, exploitation of age classes, hunting ranges, and seasonality (cf. Howard 1929).

Increasing procedural sophistication is addressed by more stress on recovery techniques and curation of faunal remains (Weigelt 1989, Wintemberg 1919). Pioneering zooarchaeologists sought accurate identification of specimens, improved recovery methods, and appropriate measurements to properly interpret archaeofaunas (Clason 1983; Hargrave 1938; Howard 1929; Merriam 1928). Changes in anthropological theory by Taylor (1948, the conjunctive approach) and Steward (1955, cultural ecology) stressed cultural behavior and information about former lifeways inherent in artifacts. Based on their work, interest in ecologically-based cultural adaptations rose dramatically (Reitz and Wing 1999:20). The standard practice continued to be collecting unquantified descriptions of unmodified faunal specimens that were relegated to brief appendices or notes (Hadlock 1943; Tyzzer 1943; Webb 1959).

Taylor's (1948) definition of the conjunctive approach was a key step forward in the development of zooarchaeological method and theory. Archaeologists had a sound basis through which to interpret archaeofaunas. Zooarchaeology became more recognizable as a field of study within archaeology and had a greater role in concerns about site formation processes, methodology, and interpretation of sites (Reitz and Wing 1999:21). Sampling issues and the role of archaeofauna transformation through cultural and natural processes were recognized as major concerns (Byers 1951; Dart 1957; Efremov 1940; Parmalee 1957a, 1957b; White 1956).

In a series of methodological papers in the early 1950s, White (1952, 1953a, 1953b, 1954, 1955, 1956) established the importance of paleontological techniques to estimate the minimum population represented by archaeological site collections. He also advanced methods of reconstructing cultural butchering patterns by analyzing damage. A major shift in emphasis to interpretation of meaning marked a more mature phase of zooarchaeological endeavor (Lawrence 1957; Taylor 1957). Included in this emphasis on interpretation were ecological reconstruction, dietary studies, and population size estimation (Cook and Treganza 1947; Meighan, *et al*. 1958a, 1958b).

Theories that emphasized adaptive aspects of behavior dominated theoretical discussions and archaeological practices during the late twentieth century (Willey and Sabloff 1974:189). This is especially true in functionalist analyses of subsistence strategies (Barker 1985:19-25; Dunnell 1986; Hesse 1995). Reflecting increased emphasis on scientific process and empirical methods, including hypothesis testing, zooarchaeology concentrated on general laws about the interaction between the environment, humans, and their culture, including its technological component (Clarke 1968:38-42; Jochim 1981; Reitz and Wing 1999:22). The combination of ecological principals with empirical data from archaeology was used to test cultural models.

During the latter twentieth century, explanatory mechanisms from processual archaeology, ecological anthropology, and the large amounts of biotic data from research projects combined to advance zooarchaeological study in the direction advocated by Taylor (1948). Concepts emerged from the archaeological mainstream to become dominant in zooarchaeological research. These concepts included the study of middle-range theory and the study of strategic decisions in culture's decisions concerning the acquisition and allocation of resources through use of ecological and economic models (Reitz and Wing 1999:23).

Middle-range theory is based on empirical, actualistic examination of technology, subsistence, and settlement patterns in modern populations that allow the modern processes and principles responsible for archaeological site formation to be used as analogs to interpret prehistoric human behavior (Bettinger 1991:61-62; Binford 1977:6; Grayson 1986; Raab and Goodyear 1984). Differentiating between natural and cultural processes and their impacts on the archaeological record is fundamental to understanding cultural behavior because the consequences of cultural behavior must be identified and understood (Reitz and Wing 1999:23; Thomas 1971). Archaeologists adapted methodological and theoretical tools from within anthropology and other disciplines to accomplish these goals. Behavioral archaeology and ethnoarchaeology both originated from this need for actualistic studies to base archeological theory on (Gould 1978;

Schiffer 1976). Binford's (1980) polar distinction between ends of a cultural continuum described by different combinations of settlement patterns and technologies formed the basis for these studies.

Site formation processes are often equated with middle-range theory and guided the interest of influential geo-archaeological studies (Bettinger 1991:77-82; Gifford-Gonzales 1991; Kroll and Price 1991:310; Thomas 1986). Evaluations of sample sizes, methodologies, and taphonomy emerged, especially concerning cultural decisions about butchering of animal carcasses and dispersal of products from those carcasses. Wintemberg (1919) presaged consideration of such topics much earlier. Thomas and Mayer (1983:Figure 188) considered the cultural value placed on animal carcasses versus the transportation costs between kill/butchering sites and other sites where most consumption occurs.

Other middle-range theories focus on regional analyses, including site catchment and site location (Bettinger 1991:66; Gamble 1984; Higgs and Vita-Finzi 1972). Such analyses investigate areas and resources thought to be most used by inhabitants of an existing settlement or archaeological site, often conceptualizing economic behavior between centers on a local (gravity model) or regional scale (central-place model) (Crumley 1979). Adaptive strategies and distribution of resources based on least effort are the usual subjects considered by such analyses.

Decisions involving budgets of resources that arise from all aspects of human behavior form the basis of game theory (Clarke 1968:43, 73, 85, 90; Earle and Christenson 1980). Beyond those concerned with nutrition, decisions investigated by game theory involve prestige, raw materials for technology, land, time, energy, or specialized knowledge and skills. Such decisions are patterned solutions that have multiple outcomes, such as a reduction in labor, increased yield of raw materials, or lower risk (Clarke 1968:45-53; 1972).

The competing optimality model is based on an assumption that foraging decisions that characterize human diets are based on an on-going analysis of the costs and benefits of procurement (cf. Hawkes and O'Connell 1981; Perlman 1980; Smith and Winterhalder 1992; Thomas 1986; Winterhalder 1987; Winterhalder, *et al.* 1988). Theorists using optimality believe that human beings make rational decisions when foraging to maximize the net rate of energy captured (Bettinger 1991:84; Jochim 1981:9-10). A well-known component of optimal foraging theory is diet breadth. Winterhalder (1981) compares resource abundance, individual energy produced by each resource, amount of energy needed to obtain each through search or pursuit, and amount of energy needed to ready each resource for consumption.

Also important in zooarchaeological development since 1960 have been contract research programs due to the large amounts of data that they have provided. Statutory requirements to include archaeological research in land-altering projects have fostered contract research programs termed cultural resource management (CRM) in the United States. CRM programs often have limited objectives, use emergency recovery procedures, and have only short project duration with limited data recovery. The sheer number of CRM projects has added large amounts of data with a concentration on subsistence, site function, seasonality, and economic studies in research designs (Reitz and Wing 1999:27).

The three most prevalent current research orientations in zooarchaeology are concerned with anthropological research, methodological research, and biological research. Methodological research in zooarchaeology centers on understanding how first-order changes in archaeological deposits and materials originate from biotic and abiotic processes, including cultural decisions (Lyman 1994a; Reitz and Wing 1999:28). Other emphases stress an understanding of second-order changes induced by research strategies, collection methods, and specimen identification procedures in order to determine the biases that affect the interpretation of collections (Payne 1972). An increasingly quantitative approach to evaluating these changes has been used over the past two decades (Grayson 1984; Reitz and Wing 1999:28).

Theoretical research stressing both anthropological and biological perspectives has also become more important in zooarchaeology during the past two decades. The anthropological perspective in zooarchaeology has been concerned with relationship between humans and animals. Much of the concern has centered on causes for continuity and change in ecological and economic aspects of human behavior (cf. Brewer 1992). Subsistence behaviors obtain foodstuffs to directly meet human biological needs for specific dietary requirements and meet other, more cultural needs (Reitz and Wing 1999:28).

ARCHEOLOGICAL STUDIES OF BONE MODIFICATION

The potential time depth in most archaeofaunas lends utility to their use in studying a varied suite of theoretical problems and technical issues. Their utility has led to use in investigating problems that span almost the complete range of human evolution (Lyman 1994a:306). An examination of the processing of fauna into consumable parts, specifically by butchering is incorporated into most current research. Lyman (1987a:251-252) labels butchering as a singularly human trait. Other researchers have included study of modifications that reflect deliberate fracturing of bone. Bone fracture research has been shrouded in controversy since Dart (1957) proposed this as a mechanism for the cause of breakage in African Plio-Pleistocene faunal materials.

Archaeological Studies of Human Butchering Behaviors

Two researchers were most influential in the application of methodologies to investigate remnants of human butchering in the archaeological record (Lyman 1994a:306). The first of these is Shipman (1981a, 1981b, 1983, 1986a, 1986b, 1987, 1988; Potts and Shipman 1981). She used scanning electron microscopy (SEM) techniques to identify butchering-induced cut marks on bones recovered from Plio-Pleistocene aged cultural strata at Olduvai I sites. Bunn and Kroll (1986:436; cf. also Bunn 1981, 1982, 1983) built upon Shipman's methods. Bunn's addition was that frequency distributions for cut marks must make anatomical sense to have meaning for patterned human behaviors of carcass skinning, joint disarticulation, and defleshing.

Documenting Systematic Butchering

Shipman's research led to critical assumptions that:

a) near-joint cut marks relate to disarticulation,

b) cut marks on meaty bones relate to defleshing and/or filleting of meat from a carcass,

c) cut marks on metapodial skeletal elements from the site's artiodactyls relate to skinning, and

d) an analogue for a systematic butchering pattern may be found in the frequency of near-joint and mid-shaft loci on meaty vs. non-meaty bones contained in a control.

Her analytical methods using frequency distributions of cut marks across anatomical loci were a revolutionary shift from contemporary practices (Lyman 1994a:307).

Bunn and Kroll's work led to inferences that:

a) abundant cut marks on limb bones with more plentiful meat indicate that larger quantities of meat were removed from those elements,
b) bones with plentiful meat have a higher proportion of cut marks in small to medium mammals than in large mammals,
c) ruminant metapodials with cut marks reflect skinning, and
d) cut marks at mid-shaft loci reflect defleshing through removal of muscle masses at their insertion points on the bone.

Significant variation in the location and orientation of near-joint cut marks may reflect how long after an animal's death it has been broken into consumable components (Lyman 1987a:263-265, 1987b:711). Separation into consumable components, often by disarticulation, may occur through human butchering or scavenging (Binford 1981).

Bunn (1983; Bunn and Kroll 1986) suggests that a thorough and systematic butchering process was applied to ruminants on the basis of the frequency distributions of proportions of cut marks across different anatomical loci. Human butchers removed significant amounts of meat (Bunn 1983; Bunn and Kroll 1986). Binford (1988:127) is critical of this position. He notes that the frequency of cut marks not reflecting disarticulation is a function of a differential investment by the butcher in removing issue from the carcass. Bunn and Kroll's (1988:144) reply that a simple comparison of cut mark frequencies among skeletal elements and animal size groups cannot be the sole basis for establishing the amount of meat present on a carcass when it was butchered. Their inference about frequencies at Olduvai Gorge are similar to those in much later analogues where cut marks indicate removal of significant amounts of meat from skeletal elements, such as those reported by Gifford, *et al*. (1980) and Marshall (1986).

Lyman's (1994:310-314) review of this debate notes alternatives that were previously not examined. More critically examining the statistics, he notes that the proportion of cut marked bone is not significantly different between size classes and suggests that both were intensively butchered. He also finds no correlation between the total number of identified specimens per anatomical category and the proportion of cut marked specimens per anatomical category for either size class. The proportion of cut marked bones is not a function of sample size. There are differences in the manner in which size classes were butchered when there is a direct correlation between the frequency of cut marked bones and butchered bones.

Lyman (1994a:311-312) tested Bunn and Kroll's (1986) conclusion about limb bones with more plentiful meat versus those with less meat. He made the assumption that metapodials contain less meat than more proximal limb elements such as the humerus, radius-ulna, femur, and tibia. He found no significant difference in the proportional frequencies of cut marked metapodials, but significant differences in the proportions for cut marked proximal limb elements. Lyman's analysis included a stratification of the cut mark data based on more precise anatomical position that included the specific skeletal element articulation which cut marks were related to. The significant differences relate to a more frequent butchery of small bovid knee joints and large bovid tibiae.

Lyman (1994a:313) directly examined Binford's (1981, 1988) positions on joint tightness versus proportion of cut marks and the relative food utility of various elements. He found no significant correlation. Frequencies of cut marked elements should also be compared to frequencies of elements modified by fracture. His rationale for suggesting this was that the food utility may reflect the importance of marrow and bone grease, in addition to meat, and may reflect deliberate fracture to obtain these products. Lupo (1998) investigated extraction rates for marrow in modern members of the horse and deer families, but noted that strategies for retrieval of marrow had implications for interpreting earlier hominid scavenging behavior.

North American Application

Many aspects of basic human behaviors, such as butchering, were transmitted to humans that colonized the Americas during the late Pleistocene. Rancorous debate surrounded the question of interpreting bone tools from the Old Crow Basin of northwest Canada (Binford 1981; Bonnichsen 1977, 1978, 1979; Frison 1970, 1974; Haynes 1981; Johnson 1976, 1982; Miller and Dort 1978; Tatum and Shutler 1980; Wheat 1979). Some of the debate examined the concepts of modification of bone by natural agents, such as carnivores or weathering, vs. butchering and other types of culturally-induced bone modification (Johnson 1985:201).

Butchery goes beyond Russell's (1987:386) notion of its goal being only to "remove meat". His definition was more restrictive than Binford's (1978) earlier definition (Lyman 1994a:295). Binford's (1978:63) explanation of butchery recognized broader goals to partition a carcass into component parts through activities that happen between killing of prey and its final consumption or discard. These activities include dismemberment, skinning, defleshing, and other actions to remove, distribute, and use carcass components. Binford (1978:63) uses the term "sets of bones" for component parts produced by butchering. These parts should be archaeologically visible as results of an extraction process yielding muscle, skin, and fat products (Lyman 1994a:295).

Lyman (1987a:252) defines behaviors and results of hominid butchery. Behaviors are labeled as butchering processes or techniques. Results are defined as the butchering pattern. The butchering process does not include cooking or consumption. However, several stages of butchering may occur, including further post-cooking reduction of carcass components into smaller portions.

North American zooarchaeology adopted a new perspective incorporating the research results of Shipman and her associates. Most appropriate were the results concerned with the anatomical location and characteristics of marks left behind by cutting tools used during carcass processing, especially signatures of stone tools. Precedents for this perspective are found in the work of Guilday, *et al.* (1962).

An increased knowledge and use of taphonomy by Shipman and her associates (cf. Bunn 1981, 1982; Olsen 1988; Potts 1982; Potts and Shipman 1981; Shipman 1981a, 1981b; 1983, 1986a, 1986b, Shipman and Rose 1983a, 1983b; Shipman, *et al.* 1981; Walker and Long 1977), Bonnichsen (1979), and Morlan (1980) also occurred. Application of taphonomic principles led to suggestion of alternative mechanisms for producing similar scratches on fresh bone that were clearly known to be possible. Ways were sought to distinguish between cultural and natural agencies, including trampling and tooth marking by carnivores or rodents (Behrensmeyer, *et al.* 1986, 1989; Eickhoff and Hermann 1985; Fiorillo 1989; Gibert and Jimenez 1991; Haynes 1993; Haynes and Stanford 1984; Lyman 1987a; Marean and Bertino 1994; Noe-Nygaard 1989; Schmitt and Juell 1994; Shipman and Rose 1984).

Replication of similar anatomical placement of marks on multiple specimens has developed into a measure of primary importance in distinguishing between culturally-induced marks and those produced by natural agencies. Guilday, *et al.* (1962:63) suggested that cut-marks related to butchery or skinning should have a detectable purpose for their location on an animal's anatomy, such as dismemberment or muscle removal. This second criterion relates to an idea of efficiency in butchering or skinning that results in functions for each mark (Lyman 1994a:298).

Binford (1984b:247) distinguishes between cut-marks made for disarticulation, skinning, and filleting or meat removal. Skinning leaves cut-marks on distal portions of the extremities, the lower margins of the mandible, and on the skull. Disarticulation cut-marks are considered to be limited to articular surfaces of long bones or their edges and the surfaces of vertebrae and portions of the pelvis. Filleting or meat removal leaves marks parallel to the long axis of skeletal elements (Binford 1984b:247).

Zooarchaeologists currently record the location and orientation of cut-marks. Hammerstones were used to break bones for various purposes, including marrow and bone grease removal, but have also been used both to detach muscle masses at their insertion point on bones (Blumenschine and Selvaggio 1988, 1991; Bunn 1982:44; Lyman 1994a:298, 1995:236-240; Morlan 1980:50; Potts 1982, 1988). In use as a butchering tool, hammerstones also left distinctive marks.

Subsidiary activities damaging bones occur during butchering and including removal of viscera or blood vessels and extraction of brain, marrow, grease, periosteum, and sinew tissues (Lyman 1987a). Butchery is divided into a series of cumulative stages due to the complexity of the process (Lyman 1987a). These discrete stages include kill-butchery (primary butchery) prior to possible transport, secondary butchery (usually at the site of consumption), and final butchery-consumption. His expectation is that bones from later stages in this process may exhibit more cut-marks than those from earlier stages because they are subjected to more butchery activities (Lyman 1994a:300).

Archaeofaunal remains rarely represent consumption byproducts at kill-butchery sites. Kill-butchery remains are identifiable because they are less fragmented (Lyman and O'Brien 1987). Sites later in the butchery process have more consumption byproducts present because more subsidiary activities may have occurred (Lyman 1987a). This positioning later in butchery results in more intensive processing of the carcass, which may yield more bone fragmentation and reduce identification of specimens. Zooarchaeologists assume the frequencies of bones exhibiting evidence of butchery are positively correlated with the frequencies of butchered bones and represent unambiguous quantitative indicators of human butchering behaviors (Lyman 1994a:302-303). This theoretical assumption has not been borne out in ethnoarchaeological research yet, but it has led to methodology for quantifying evidence of marks left by carcass processing which differs from that used to determine taxonomic abundance (Lyman 1994a:304).

Varying frequencies of skeletal elements allowed an inference that bighorn sheep from Horizon 2 at Gatecliff Shelter represented a later stage of butchery than other portions of the site's archaeofauna (Thomas and Mayer 1983). Transport logistics involved in moving products of kills towards the site of final butchery and consumption have an effect on both the specifics of butchery operations used in any situation and the resulting damage evident on the bones remaining in the collection studied. Binford (1978, 1984b) identifies these influencing effects determining how an animal carcass is butchered and transported as contingency factors.

Various measures have been used to express the relationship between archaeofaunas and the original collection of live animals represented by them. Among these measures are the number of identified specimens per taxon (NISP, an observational unit) and the minimum number of individuals necessary to account for an analytically specified set of faunal remains (MNI, an analytical unit). Both of these are widely used, quantitative units. MNI and NISP may refer to either complete specimens (including skeletal elements) or analytically specified portions of them, including fragments (Lyman 1994a:100-101). To estimate the more complex MNI measure for each taxon, element, symmetry (side), age, sex, size of individual, and archaeological context are analyzed for the most numerous complete element.

Other quantifiable units have assumed major roles in recent taphonomic analysis and represent a refinement in how frequencies of skeletal elements are enumerated (Lyman 1994a:102). The minimum number of elements (MNE) was defined to measure portions of skeletons by analytically specified anatomical units to allow frequencies of partial skeletal elements to be quantified (Binford 1984a; Bunn and Kroll 1988; Grayson 1984; Hesse and Wapnish 1985; Potts 1988). The anatomical units used in MNE may include fragmentary skeletal elements. As with MNI, MNE may account for observed differences in age, sex, and probable body build of the original animals. The MNE estimate more specifically allows reconstruction of the number of whole elements from identified specimens, allowing butchering units to be defined (Lyman 1994b:290).

The ratio between NISP and MNE may be used to measure the degree of fragmentation of enumerated skeletal elements, so the method of how MNE values are derived from specimens is of interest. Marean and Spencer (1991:649-650) define two methods of computing MNE values, one of them similar to a summed percentage method used by Klein and Cruz-Uribe (1984). Bunn and Kroll (1986, 1988) provide three methods to derive MNE values, based on the number of articular ends and limb bone diaphyses present. Lyman's (1994a:104) critical observation that the zooarchaeologist must explicitly identify the criteria used to derive the MNE values is wise given the variety of methods in use.

The distribution of cultural modifications such as cut-marks relates to carcass processing behaviors that damage skeletal elements on which cut-marks or other physical indicators are located (Lyman 1987a; Maltby 1985a, 1985b). Clusters of adjacent cut-marks are often recorded as an aggregate (cf. Lyman 1987a, 1992, 1995). Recording and interpretation requires accounting for taphonomic and diagenetic factors that destroy bone surfaces that might have exhibited cultural modifications. Factors may include weathering, destruction by scavengers or carnivores, root etching, and other physical stresses which remove evidence of cultural modification by altering the surface of the bone (Lyman 1994a:306). Positive evidence of surface alteration by other means correlates just to the absence of butchering damage at any particular anatomical location, not to negative evidence of it (Lyman 1994a:306).

Evidence for carcass processing is highly variable and complicated by the fact that it occurs under variable physical circumstances that alter methods used and the resulting evidence. Binford (1984a:110-112) notes that these circumstances may have varied from immediately after death (e.g. when fresh and supple), several days old (e.g. slightly to substantially desiccated and stiffened by rigor mortis), or after being exposed to high latitude winter conditions (e.g. frozen for several months).

Archaeological Studies of Human Animal Bone Processing

Dart's (1957) claim that the Plio-Pleistocene Makapansgat fauna contained specimens that had been deliberately fractured by hominids in ways which left behind distinctive signatures touched off a significant controversy (Brain 1989; Hill 1976; Maguire, *et al*. 1980; Read 1971; Read-Martin and Read 1975; Shipman and Phillips 1976; Shipman and Phillips-Conroy 1977; Wolberg 1970). Controversies surrounded later claims for similar types of phenomena in North America (Bonnichsen 1973, 1979; Haynes 1983; Irving and Harrington 1973; Irving, *et al*. 1989; Johnson 1983, 1985; Lyman 1984a; Miller 1969, 1975; Morlan 1980, 1983, 1984, 1988; Sadek-Kooros 1972, 1975). Both controversies involve questions about whether animal bones deliberately broken by humans may be distinguished from those broken by other physical means, including carnivores and non-biological causes. Determining the cause of specific cases of animal bone breakage requires knowledge of the physical nature of bone and how specific agents act to of break bone.

Synopsis of the Physical Structure of Bone

Bone is a composite, two-phase material made up of hydroxyapatite mineral crystals contained in an organic matrix (Currey 1984:26; Francillon-Viellot, *et al*.

1990:515; Lyman 1994a:72; Meinke 1979). The crystals are elongated hexagon in shape (Sinkakas 1964:416). Hydroxyapatite is a highly diverse suite of hydrous calcium phosphate compounds that contain minor amounts of other inorganic elements. Chemical additions to hydroxyapatite affect the stability of bone during life and subsequent diagenesis (Carlson 1990:531). The organic matrix is about 30 per cent of bone's weight and is made of long fibers of the structural protein collagen.

Hydroxyapatite resists compression forces, conferring rigidity and hardness, while collagen resists tension forces and confers toughness, resiliency, and elasticity (Hildebrand 1974:96; Lyman 1994a:72; Romer and Parsons 1977:150). The long axis of the hydroxyapatite crystals is aligned with the much longer collagen fibers. The crystals occur both within the collagen fibers and surrounding them (Currey 1984:26). Bone serves as a metabolic reservoir for many minerals, and continually exchanges them with the soft tissues. Variations in chemical concentrations affect the bone's physical characteristics (de Rousseau 1988:95; MacGregor 1985).

Bony tissue may be formed by replacement of existing cartilage, the formation for endochondral bone (Lyman 1994a:73). This type of bone is divided during growth and development of long bones in young vertebrates into three distinct parts, ends (epiphyses) and a central shaft (diaphysis). Each is a center of ossification during ontogenetic development. Cartilages separate the three growth zones. Fusion of the growth zones into one skeletal element signals the onset of adulthood in mammals. A membranous sheath termed the periosteum covers the exterior of nearly all portions of bones except the articulations. Long bone growth occurs both in length and circumference, with successive layers of compact bone deposited around the exterior of the diaphysis during growth (Lyman 1994a:73).

Bony tissue has a complex structure (Wainright, *et al*. 1976:Figure 5.14). On a microscopic scale, it is divided into cells that deposit bone material (osteoblasts) and those that remodel bone once adulthood is reached (osteoclasts) (Lyman 1994a:73). The interior cavities of some endochondral bones are lined with the endosteal membrane, similar to the periosteum (Lyman 1994a:74). A dendritic network of small canals that contain blood vessels exists within the compact bone and delivers nutrients. This network is the Haversian canals and also contains nerves. Surrounding each Haversian canal is a major element of bony tissue structure termed the osteon (Wainright, *et al*. 1976:Figure 5.14). Osteons are roughly cylindrical layers of compact bone lamellae. While the osteons are parallel to the long axis of bones, alignments of collagen fibrils and hydroxyapatite crystals vary between lamellae (Lyman 1994a:74). Linking the Haversian canals within each osteon are radiating blood vessels). Osteons are bonded to each other by chemical cement.

Mammalian compact bone may be deposited as lamellae, woven, or parallel-fibered forms (Currey 1984:26-27). The earliest bony tissue to be formed is woven bone deposited when the animal is developing *in utero* or when bone fractures are being repaired in older individuals. Random orientation of fine collagen fibrils and hydroxyapatite crystals and presence of irregular trabeculae or struts distinguish woven bone (MacGregor 1985:4). Extensive spaces around blood vessels also are a characteristic of woven bone. Lamellar bony tissue forms slowly and has collagen and hydroxyapatite crystals arranged in layers or lamellae (Currey 1984; Meinke 1979). Collagen fibers are grouped within lamellae. The orientation of groups may vary between adjacent lamellae. Parallel-fibered bony tissue is rare, but intermediate in structure between lamellar and woven bone. Each type of bone contains small cavities pervading the structure of the bones; these are termed lacunae. Blood vessels in all three are contained within canaliculi, or small channels that extend through the bone.

Currey (1984:28-29) also notes that four types of bone exist on a more general structural scale; woven bone, lamellar bone, Haversian system lamellar bone, and fibrolamellar bone. Lamellar bone extends around the outside surface of mammalian long bone as circumferential lamellae. Haversian system lamellar bone forms on a localized scale where new bone is deposited by osteoblasts in concentric layers at the outer boundaries of the cavities surrounding blood vessels. These vary considerably in layout, but all contain a cement layer with very few penetrations, effectively isolating the surrounding bone metabolically from the Haversian system (Currey 1984:29). Fibrolamellar bone, also known as laminar bone, has characteristics of both woven and lamellar bone. It forms in large mammals where long bones grow quickly in diameter. Woven bone rapidly is built into a framework then filled in by lamellar bone, creating alternating layers of woven and lamellar bone (Currey 1984:29; MacGregor 1985:5).

Using these components, skeletal elements exhibit structural characteristics that contain several different types of bony tissue (Lyman 1994a:76). Compact bone is found in the diaphysis of long bones in mammals and birds, made of lamellar, fibrolamellar, and Haversian system lamellar bone. The diaphysis also contains an internal space, the medullary cavity that contains marrow, a softer, fat-rich tissue in mammals. In birds, the diaphysis is thinner walled and the medullary cavity may contain calcium used for egg-shell production (MacGregor 1985:8). The epiphyses of birds and mammal long bones contain cancellous or spongy bone made up of trabeculae interspersed with marrow. Fish, reptiles, and amphibian bones are different. Amphibian bone is compact and lacks Haversian systems, as does the bone in most lizards and snakes (Enlow 1969:45, 47). A limited amount of cancellous trabeculae exists in mid-diaphysis in lizards (Enlow

1969:62-63). Turtle shells are specialized elements that have an inner cancellous layer bounded by vascularized compact, lamellar bone (Zangerl 1969:313). Teleost fish bones lack osteocytes (Currey 1984; Enlow 1969; Lyman 1994a).

The amount and distribution of cancellous and compact types of bony tissue in individual skeletal elements depends on the structure and function of the element (Romer and Parsons 1977:151). Anatomists recognize several basic shapes of skeletal elements (Currey 1984:36; Davis 1987:47; Micozzi 1991:54). Long bones are typically tubular in shape with an elongated shape, roughly circular cross section, and expanded ends; they include ribs, limb bones, the mandible, and the human clavicle. Tabular or flat bones are flattened and include the bones of the pelvis, scapula, and portions of the skull vault. Short bones include phalanges, carpals, tarsals, metacarpals, and metatarsals. Irregular bones include vertebrae, many skull bones, the hyoid, and the patella.

Antler and horn are hard tissues that are also part of the exoskeleton (MacGregor 1985:19). The keratinous sheath of horn grows around a vascular bony core. The horn core develops as a separate center of ossification which later fuses permanently with the bones of the skull (Goss 1983:67). Antler is a seasonally growing hard tissue structurally similar to bone that originates within a specialized skin covering the frontal bone of the skull in the deer family (Cervidae). It is often branched into tines and consists of compact woven bone encasing a cancellous central core which is smaller or absent near the tips of the tines (Goss 1983:57; MacGregor 1985:12-13). Antlers are shed annually.

Bone Biomechanics

Bone breaks when force exceeding the material’s tensile strength is applied to it (Evans 1961:110-111; Johnson 1985, 1989). Loss of moisture within the bone’s structure changes the manner of failure. In the living state and immediately after an animal’s death, bone is ductile and responds to mechanical force by deforming prior to structural failure (Evans 1973; Johnson 1985:161). Moisture escapes from the bone's structure after death and causes a more brittle response to mechanical force because the bone is harder, stiffer, less elastic, less able to absorb stress, and permanently deforms when strained (Amprino 1958; Evans 1961, 1973; Hayes and Carter 1979). Thermal alteration of bone makes the bone less ductile by removing moisture from the bone's structure. Thermal alteration results in decreased compressive and tensile strengths, reduced elasticity, and increased bone hardness and microhardness (Frankel and Burstein 1967; McElhaney 1966; McElhaney and Byars 1965; Sedlin 1965). A direct result of post-mortem moisture loss is that the physical bonds between adjacent osteons and lamellae are reduced to failure.

Bone breakage in structural failure may be due to a biomechanical response to forces that create stress-strain relationships. Three types of force exist: tension, compression, and shear (Evans 1961:110). Tension pulls two portions of a body apart. Compression refers to those that act to push them together. Shear is the force that acts to slide adjacent parts in opposite directions.

The way an element resists forces determines its ability to resist structural failure and fracturing. Bone from living animals or fresh carcasses has a completely hydrated structural matrix that will deform plastically unless micro-cracking is initiated that begins all subsequent fractures (Johnson 1985:168). Bone will absorb large amounts of stress without fracturing, but irreversible microscopic deformation occurs cumulatively (Bonefield and Li 1966:874). Micro-cracking begins at the in cement lines surrounding osteons (Evans 1973). Larger cracks amplify the damage (Bird and Becker 1966; Sweeny, *et al*. 1965).

Long bones undergo stress-strain conditions under four variations of force loading (Evans 1952:265, 1973; Johnson 1985:170). Concentrically applied forces compress the element in parallel with the element's diaphysis. Eccentrically applied forces load the element off-center with the element's long axis, bending it and producing both compressive and tensile stress and strain. Loading the element perpendicular to its long axis also bends the element. Finally, a torsional or twisting force applied to an end of the element results in tensile and shear stress and strain. Loading may occur over a broad area of the bone, or as a force concentrated in a much smaller point. Force may be applied either a statically (constant) or dynamically (suddenly).

Bone fractures when dynamic loading exceeds the element's tensile strength (Evans 1961:114). Twisting of long bones during dynamic loading produces shear and tensile failure. Fractures begin at the point of highest tensile strain on the exterior of the bone (Evans 1957; Herrmann and Liebowitz 1972:808). The fracture and resulting fragment morphology are affected by the dynamic interaction between the force applicator, fracture dynamics, and bone structure (Bonnichsen 1979:43; Johnson 1985:170). Stress waves discharge kinetic energy. They are released during initial application of force and later in the fracture process. Stress waves influence movement of fracture fronts and affect the fragmentation of bone elements where fracture fronts intersect (Bonnichsen 1979:15). They also initiate micro-features that determine the appearance of resulting fracture surfaces. The epiphyses of long bones reflect and diffuse stress waves due to the presence of trabecular bone. Fracture fronts in fully hydrated bone from living or freshly dead animals will not crosscut epiphyseal ends (Bonnichsen 1979:43).

The morphology of long bones resists bending (Johnson 1985:171). M most long bones are hollow tubes with bending strength that exceeds tensile strength of the diaphysis (Hayes and Carter 1979:278). Bending strength and stress are important if a long bone is subjected to eccentric or perpendicular force during dynamic loading

(Johnson 1985:171). Bending stress combines compressive, tensile, and shear stresses, each acting on a different portion of the diaphysis during this type of dynamic loading. The magnitude of stress and strain of each type is higher at the surface (Evans 1961:112, 1973:26-27; Hayes and Carter 1979:278).

When the elastic limit is exceeded, bending of a long bone produces crushing at the impact point prior to any tensile failure. Torsional rotation or twisting occurs if the epiphyseal ends are not immobilized. Shearing occurs along a helical course inclined at 45° to the skeletal element's long axis at the point where shearing and tensile stresses are equal (Evans 1973:20-21). This produces spiral or, more properly, helical fractures. Structural failure is first evident on the side experiencing tensile stress, but is preceded by localized failure on both sides (Carter and Hayes 1977; Hayes and Carter 1979).

Analysis of the Archeological Record

Taphonomists have typically concentrated on morphology of fractures (Davis 1985; Lyman 1994a:318). Many agents that produce similar morphologies may break bone during life and soon after death. Zooarchaeologists and other taphonomists have developed analytical tools to determine the timing and causative agents for bone fractures. These aid identification of human agency involved (Lyman 1994a:318-324).

Davis (1985) recognized eight factors concerning the fracture of complete skeletal elements. These were:

1) the physical size of the taxon represented does not influence bone fracture patterns when taxa are sorted by live weight of the animal represented;
2) gross morphology or macro-structural differences between skeletal elements determine fracture locations and underlie differences in cross-sectional thickness of cortical bone between elements and the presence of anatomical features such as crests (Davis 1985:94);

3) micro-structural differences between elements exert influences on fracture form due to different alignments of osteons and the collagen bundles and hydroxyapatite crystals that compose them (Davis 1985:97);
4) the effects of increased weathering on the physical structure of elements being fractured are reflected in a reduced proportion of fracture morphologies typically encountered in fresh bone;
5) differences in resulting fracture morphologies result from bone being subjected to static loading vs. dynamic loading (Davis 1985:108);
6) the inherent structural properties of bone result in expectation of a high percentage of oblique or spiral fractures in any assemblage (Davis 1985:29);
7) oblique, spiral, or helical fractures will occur with higher than expected frequencies under static or torsional loading and lower than expected frequencies under dynamic loading due to the inherent differences in strain rates between these loading types (Davis 1985:133); and
8) fractures produced under dynamic loading are more likely to have rounded distal ends.

Johnson (1985:172) uses characteristics of fracture location, fracture front, surface, and shape to discuss the attributes of bone breakage. Discussion centers on the anatomical location for the break, the direction in which the fracture front proceeded, the cross-section of the bone that failed, and the plan-view configuration of the bone. Most bone fracture is too ambiguous to identify agents involved in breakage (Marshall 1989; Shipman, *et al*. 1981). Taxon size is a definite factor in bone fracture and should be a major component in comparing faunal collections in attempting to determine the causative agent (Shipman, *et al*. 1981:259). This is a logical conclusion, given the micro-structural differences between taxa (Lyman 1994a:318). Agreement exists about the relationship of the moisture content of bone to performance when fracture is initiated.

Examples of fracture type typologies Marshall (1989:14, Figure 1), building on the work of Shipman, *et al*. (1981). He accounted for eight types of fractures, including:

1. stepped/columnar,
2. saw-toothed,
3. V-shaped,
4. flaked,
5. irregular/perpendicular,
6. smooth/perpendicular,
7. spiral, and
8. longitudinal.

Johnson's key (1985:176) differentiates between fractures occurring within living bone, long after death, and during diagenesis. This typology uses color of the bone cortex and fracture surface, fracture texture, and the fracture angle at the cortical surface. Johnson's (1985) work includes weathering of bone in its description of fractures. It differentiates between types of spiral fractures, separating Shipman's (1981b) two variants of spiral fractures (Type I and Type II) because they actually have different causes. Shipman's Type I spiral fracture is a horizontal tension failure occurring in desiccated bone not from a fresh kill (Johnson 1985:174-176). Shipman's Type II spiral fracture is a true spiral or helical fracture from an animal that is a relatively fresh kill because the surface of the fracture is rough when the break occurs during life or very soon after death. When the surface of fractures is smooth, desiccation and slight weathering is indicated. More intense weathering results in split-line cracks that may interfere with the fracture front, producing stepped, longitudinal, and smooth/perpendicular fracture types.

More intensive study of human-induced bone breakage in the archaeological record and in actualistic research has been conducted in recent decades. The research removed many earlier misconceptions that physical features of fractures could be used solely to determine the agent responsible for the fracture (Bonnichsen and Will 1980; Dart 1957; Haynes 1983, 1993; Johnson 1985; Lyman 1984a, 1994a:324; Zierhut 1967). Determining agency for bone breakage requires study of bone fracture features and the surface of the fragments themselves (Johnson 1985:175). Deliberate breakage of bone by humans for marrow or bone grease retrieval and tool manufacture may be distinguished from other fracture causes. Competing agents include carnivore and rodent activities, sub-aerial weathering, trampling, violent death through volcanic activity, falls, or other catastrophic force, and post-deposition compression by overburden (Lyman 1994a:324-325).

Removal of element epiphyses through mastication, scalloping of remaining diaphysis edges, reduction of the diaphysis into splinters, punctures from small-diameter loading points, and overall furrowing, scoring or pitting of the fragment surface are marks which reflect carnivore activity-produced static loading (Johnson 1985:192; Lyman 1994a:325). Dynamic loading used by humans leaves behind broader remnants of point loading, percussion pits, or flake scars which indicates human agency for bone breakage when used with spiral or helical fracturing, (Blumenschine and Selvaggio 1988, 1991; Johnson 1985:192; Lyman 1987a).

The absence of carnivore scoring – pitting damage or typically small loading points and the presence of true spiral or helical fractures are the visual attributes most used to indicate the presence of human-induced fractures (Lyman 1994a:326). Other physical features may be present which are dependent on specific types of dynamic loading used. A circular or oval depressed area with crushed bone or surrounding ring cracks represents the point of impact. It will usually exhibit a semi-circular notch in the outer cortical surface at the impact. Bone exhibits remnant fracture features (stress relief hackle marks and ribs radiating outward form the loading point), interference features (chattering and stepping), and wedge flakes where bending failure happens as the element is flexed (Johnson 1985:194-197).

Zooarchaeological researchers examine a broad variety of physical features in analyzing fracture patterns. Fracture types, proportion of fragmentary to whole elements, extent and intensity of fragmentation, size of fragments and NISP:MNE ratios, and identification of bone artifacts, are the more important measures used (Brink 1997; Buehler 1997; Capaldo and Blumenschine 1994; Hill and Hofman 1997:63-83; Johnson and Holliday 1997:337-348; Lyman 1994a:328-338; Marean and Bertino 1994; Quigg 1997:157-159; Schmitt and Lupo 1994; Silverstein 1980:503-504).

Interpretation has allowed conclusions about human behavior concerning prey species, butchery activities, and products that resulted. Conclusions have included seasonality of kills, possibility of communal hunting, butchery, or preparation of carcass byproducts, age-structure and potential aggregate makeup of prey species (single animals to herds of land mammals, schools of fish, etc.), the manufacture and short-term use of bone tools during butchery, the manufacture of bone artifacts for long-term use elsewhere, the pattern of butchery and degree to which carcasses were butchered or scavenged, retrieval of marrow, rendering of bone for grease and other fatty byproducts for later use, further processing of fresh meat for long-term storage (salting, drying, smoking, incorporation with fat into pemmican, etc.), etc. (Brink and Dawe 1989; Buehler 1997; Byrd 1997; Greenspan 1998; Hill and Hofman 1997:75-77; Hughes

1977:51-55; Jeffries 1997; Johnson 1987, 1989, 1991; Johnson and Holliday 1997:345-348; Lemoine 1995; Quigg 1997; Ricklis and Collins 1994; Saunders 1980; Saunders and Daeschler 1994; Speer 1978, Steele and Carlson 1989; Todd 1987). Used with data from cultural features and other artifact classes, bone fracture data enable zooarchaeologists more complete interpretations about behavior.

STUDIES OF MODERN ANIMAL BONE PROCESSING

For many decades, paleontologists, physical anthropologists and archaeologists have studied modern conditions to directly observe how natural or cultural processes may modify animal bone before and after burial and fossilization (Clark, *et al.* 1967; Haynes 1978, 1980, 1981, 1982, 1983, 1988a, 1988b, 1993; Haynes and Stanford 1984; Lawrence 1968; Lyman 1994a; Müller 1951; Olson 1952, 1958; Voorhies 1969). Such actualization studies involve direct observation and have often been approached from the field of taphonomy. Elements of taphonomy originated within paleontology several centuries ago (Lyman 1994a:17). These elements were included in a formal definition of the field by German paleontologists in the early twentieth century (Cadée 1990:4-13; Lyman 1994a:17; Rudwick 1976). German scholars viewed these studies as precursors steps to fossilization. They were known variously as *biostratonomie* (now termed biostratinomy), *fossildiagenese* (now termed diagenesis), or *aktuo-paläontologie* prior to their inclusion in the current definition of taphonomy (Efremov 1940; Müller 1963; Richter 1928; Weigelt 1989). Neotaphonomic studies are used within vertebrate paleontology and physical anthropology to better understand the physical processes that lead to the formation of paleontological localities. Taphonomy continues to grow in sophistication and importance within paleontology (Allison and Briggs 1991; Briggs and Crowther 1990; Donovan 1990; Lyman 1994a:20).

The archaeological interest is similarly directed towards the physical and cultural processes affect how archaeological sites or localities are formed, especially those processes that meet subsistence and technology needs. Dart's (1949, 1956, 1957, 1960; Hughes 1954) work was the major introduction to archaeological use of taphonomic principles. His ideas served as a catalyst that spurred American interest in the subject. One aspect of this strong archaeological interest in taphonomy is in documenting the processes that affect culturally modified bone assemblages before and after deposition.

Archaeologists rapidly adopted a taphonomic perspective. In the process, they conducted an increasingly large amount of ethnographic and actualistic research to aid interpretation of their archaeological research. Among the more important for this dissertation are the works of Bartram (1993); Behrensmeyer (1975a, 1975b, 1978, 1979, 1981; Behrensmeyer, *et al*. 1979, 1980, 1986, 1989; Behrensmeyer and Hill 1980; Boaz and Behrensmeyer 1976); Binford (1977, 1978, 1981, 1984a, 1984b); Blumenschine (1986, 1988, 1989, 1991, 1995); Bonnichsen (1973, 1979); Butler and Schroeder (1998); Domínguez-Rodgrigo (1994, 2002; Domínguez-Rodgrigo and Marti Lezana 1996); Gifford (1977, 1981, 1984; Gifford and Behrensmeyer 1977; Gifford-Gonzalez 1989a, 1989b, 1989c, 1991; Gifford-Gonzales, *et al*. 1985); Haynes (1978, 1980, 1981, 1982, 1983, 1988a, 1988b); Hill (1976, 1978, 1979a, 1979b, 1980; Hill and Behrensmeyer 1984, 1985); Johnson (1982); Jones (1986, 1990); Kent (1981, 1993); Lupo (1995); Lyman (1984b, 1989); Olsen (1988); Petraglia and Potts (1994); Shipman (1988; Shipman, *et al*. 1984a, 1984b; Shipman and Phillips 1976; Shipman and Phillips-Conroy 1977; Shipman and Rose 1984, 1988); Walker and Long (1977); and Wheeler and Jones (1989).

Skinning, Butchering, and Dismemberment

Once secured, many vertebrate prey species require some form of additional processing to be rendered useful. Some species are simply too large for immediate consumption or transportation without such work. Usually, but not always, additional processing will include removing viscera to control spoilage and to retrieve usable food or other byproducts. Occasionally, hunter-gatherers will relocate to kill sites for the duration of the kill-processing event. The potential for confrontations with large carnivores intent on scavenging exists during carcass processing.

Beyond the initial evisceration, breaking down the prey carcass into more usable component products usually first requires that its external covering be removed using either fire (singeing) or cutting implements to pierce and remove the skin (de Graaf 1981; Henshilwood 1997; Kent 1993:337-339). In the early 1970s, the Dassanetch of the Lake Turkana area in eastern Africa**,** skinned small, goat-sized mammals before butchering them (Gifford-Gonzales (1989a:185, Figure 3). Skinning was initiated by an incision on the ventral midline, followed by a circumferential cut at the proximal end of the metapodial that was extended up the leg's inner surface to join the initial midline incision. The skin was separated from the underlying muscle fascia without use of cutting tools. Terrapins and other smaller reptiles were roasted whole by the Dassanetch before butchery which removed the shells by prying or cutting apart to remove the contents (Gifford-Gonzales 1989a: 187; Gifford-Gonzales, *et al.* 1999:431). Large reptiles, such as crocodiles, were skinned in a manner similar to mammals. The Dassanetch prepared fish for consumption by removing external scales using either a bone or metal tool (Gifford-Gonzales, *et al.* 1999:403, 423).

A small mammal-skinning pattern similar to that used by the Dassanetch and San was used for small rodents among indigenous farm workers in South Africa

(Henshilwood 1997:661). An incision was made along the ventral midline and inner margins of the hind legs prior to removal of the skin by hand. However, the skin of these mole-rats was removed following roasting in coals, the skin having served as insulator and cooking container. This is very similar to the procedures described for squirrels and mongooses among the San in Botswana (Kent 1993:337).

Navaho pastoralists' skinning and butchering practices currently used for domestic sheep were documented by Binford and Bertram (1977:91-93). With the carcass lying on its side on the ground, butchery was initiated by a ventral cut from the sternum forward along the neck to the throat, followed by extension of the cut posteriorally to the tail. Beginning on the forward legs, incisions were made up the mesial side to the proximal articulation of the metacarpal where the lower leg, including skin and metacarpals, is severed by a cut through the carpals. The rear legs were butchered in a similar fashion with a cut through the tarsals severing the lower leg that remains attached to the hide. The remainder of the skin was worked free from the tail up the back to the neck and removed after the animal was hung to facilitate the remaining steps in butchery.

Binford (1978:51-62) also worked among the Nunamiut in the Alaskan Arctic and recorded their skinning and butchering methods used for caribou and Dall sheep. These inland Inuit lived in the Brooks Range and were still subsistence hunting. Caribou processing depended on final disposition of the meat—immediate consumption, drying or freezing, or caching (Binford 1978:142). Dall sheep were only prepared for immediate consumption during the warmer months (Binford 1978:142-144). Sheep were skinned following evisceration and removal of the metapodials, and then butchered. Skinning of the sheep began with a deep cut at the back of the skull to remove it. Then cuts were made up the medial aspect of the rear legs to the trunk allowing the skin on the rear legs to quickly be stripped by hand. After repeating the process on the other rear leg, the ventral cuts were joined to the cut made during evisceration. Working a hand between the skin and muscles of the haunches, the hide was worked loose ventrally to mid-body before the front legs were skinned similar to the rear legs. The ventral cut from evisceration was extended anteriorally to the neck before the hide was worked loosed from the rib cage, shoulder, and neck by hand. The final skinning operation for Dall sheep was to pull the hide off of the rump.

For use as dried meat for storage, caribou carcasses were skinned starting with cuts that allow the head to be removed (Binford 1978:94-95). Additional cuts were then made down the medial side of the front legs from the shoulder joint to a point where cuts were made around the circumference at the carpal-metacarpal articulation. Anchoring the phalange with his own foot, the butcher pulled the skin off the upper part of the front leg up to the body. The rear legs were treated similarly, but the inner cut was extended to the anus. A ventral cut was made down the sternum and across the abdomen to meet the cuts from the rear leg. The sternal cut was extended in an anterior direction up the ventral surface of the neck, and then the front leg cuts were linked to it. The hide was removed by inserting a hand under it and "punching" the fist between the muscle and hide while the other hand pulled the hide upward away from the body and removed the skin. This action was begun at the shoulders, extending dorsally to the vertebral column, and then the skin was removed from the rear of the carcass in a similar manner.

When caribou was to be used for immediate consumption as food, the removed skull was skinned by making cuts transversely between the antlers, longitudinally from that cut to the posterior edge of the remaining hide, longitudinally along the upper surface of the muzzle from between the eyes to the nose, and then around the nose to the lips

(Binford 1978:152). The resulting flaps were pulled down and removed from the ventral side of the mandible.

Caribou cows and calves hunted for clothing skins received special skinning attention, with careful attention being paid to the head (Binford 1978:151-152). Because hide on the skull is used for parka hoods, care was taken to retain the original contours of the hide as it was removed from caribou cow or calf skulls as what is termed a cape. After removing the antlers of adult or subadult caribous by cutting or sawing, a cut was made posteriorally from the chin down the ventral side of the muzzle to the neck. The skin was then "worked" upward around the lips, cut behind the nose, and worked from around the eyes, preserving the eyelids by careful work. The "working" of the hide apparently involves very careful cutting. After the skin has been removed from the muzzle, it was removed from the dorsal surface of the frontals rearward from the eyes to the antler bases. Circular cuts from the underside at the antler bases freed the hide from the antler remnants and allowed it to be pulled to the rear and completely removed.

Once skinning is accomplished, the partitioning of the carcass itself into resulting meat, sinews, fats, bodily liquids, and bone or bone products may be accomplished (Lyman 1987a:252). Portioning may involve removal of the desired products directly from the articulated carcass itself at the kill location or may require dismemberment into smaller units for transport or use (Binford 1978; Binford and Bertram 1977; Domínguez-Rodrigo 2002:11-12; Gifford-Gonzales 1989:185-187; Monahan 1998; O'Connell, *et al.* 1990, 1992). Factors affecting this decision are based on the anatomy of the prey. They may include the size of the prey carcass, season, time of day, the distance to where the products will be ultimately used, food preservation methods in use, the cooking method to be used in later food preparation, or cultural preference (Marshall 1994; O'Connell, *et al*. 1990, 1992). The removal of skeletal elements at the kill site and their deposition there is highly variable and sometimes depends on prey size, but may also be motivated by decisions to enhance further use or sharing of the resources involved (Bartram 1993; Domínguez-Rodgrigo and Marti Lezana 1996).

Among the Dassanetch, partitioning of medium to large-sized mammal carcasses during butchery was documented and reported by several researchers (Gifford-Gonzales 1989:185-186; Lupo and O'Connell 1999:87). The pattern of butchery among this group is dependent on the size of prey.

For the smaller sized prey, Dassanetch butchery was initiated by cutting the proximal articulation of the metapodials that are removed with the hide (Gifford-Gonzales 1989). The ribs were then separated from the sternum as a group and their vertebral articulation was broken. The muscles associated with the scapula and forelimbs were severed from the vertebral column. Once the forelimb-rib units were removed, the muscles around the scapula were cut and separated to sever the forelimbs from the ribs. Returning to the carcass, the next action cleaved the remaining sternum attachments and removed the belly muscle masses from the carcass. Continuing, the vertebral column was removed by severing at the thoracic-lumbar and thoracic-cervical articulations and then subdivided by cutting through between the third and fourth thoracic vertebrae. The head was removed by cutting between the atlas and axis (first and second cervical vertebrae), and then the neck was subdivided by cutting through the articulation between the third and fourth cervical vertebrae. The final actions taken to butcher carcasses of this size was to crack the pelvis at the pubic symphysis, sever the iliac-sacrum articulation by cutting and levering it apart, detaching the hind quarters from the sacral unit.

The Dassanetch butchered fish by cutting off the head and epaxial spines of the fins, prior to further butchery and either boiling, roasting, or drying (Gifford-Gonzales, *et* *al*. 1999:403, 410, 423, 437). On larger fish carcasses, the braincase was separated from other portions of the skull and broken open to remove its contents (Gifford-Gonzales, *et al*. 1999:437). Production of dried fish for trade also documented (Gifford-Gonzalez, *et al*. 1999:410). South Asian market fishers butchered fish larger than 25 cm in length in a manner similar to that used at Lake Turkana—gills, viscera, fins, and tails were removed and discarded early in the butchery process (Belcher 1984). For fish in excess of 1 meter in length, the head was separated from the carcass and also used.

In North America, Flenniken (1981:77-90) observed butchery of flat and round fish by the Makah tribe of the U. S. Northwest Coast using tools replicated from prehistoric originals. Traditional butchery methods were used by skilled Makah women butchers who prepare salmon and halibut for smoking and drying. Their methods included decapitating each fish, removing the vertebral column and fins, and separating the remaining flesh into several fillets.

Salmonid fish processing in the northern Pacific Rim is a topic of great interest among archaeologists working in the region, due to its role in understanding the evolution of storage-based economies (Hoffman, *et al*. 2000:699). A wide variety of methods are documented for salmon butchery, depending on several factors that include intended use, season and current weather conditions, and condition of individual fish (Fall, *et al*. 1984:98-113, 1996:52-55; Hutchinson-Scarborough and Fall 1996:43-52; Stanek 1985:141-144; Seitz 1990:68-69). All methods separate the head and entrails from the body. For storage after drying and smoking, dressed fish carcasses are split lengthwise and filleted into several fillets as a first step. Further processing used for larger salmon species or more fatty individual fish removes the fins and vertebrae from the fillets, although tail elements of the vertebral column are left in place to connect the fillets for drying (Hutchinson-Scarborough and Fall 1996:45; Seitz 1990:69). When sufficient time and labor are available, the heads, fins, tails, and entrails may be fermented together. These methods are similar to others reported ethnohistorically from salmon waters in western North America (Hoffman, *et al*. 2000:701; Kennedy and Bouchard 1992:290-298; Nelson 1983:267-268; O'Leary 1992:62-88; Romanoff 1992:233-241; Stewart 1977:129-146).

Other North American fish processing among Alaskan Inupiat in the Meade River delta has been observed (Chang 1988). Arctic char are harvested and processed, as are whitefish. Whitefish are cleaned and prepared for use by vertical filleting cuts to remove the entrails and all of the skeleton except the tail (Chang 1988:155). The tail elements and skin remain attached to the two fillets of flesh.

Lupo and O'Connell (2002:87) documented a different order of activities used by the Dassanetch for larger prey carcasses. Butchery began by removing the hindquarters as individual units using a cut to the head of the femur, separating them from the acetabulum. Front limbs were removed as a unit with the scapula, with similar cuts being made as documented for smaller prey to separate the forelimb-scapula units from the ribs. The muscles and other tissues covering the ribs were then cut away. The skull was removed, usually using a heavy chopping tool, prior to cutting away the *longissimus dorsi* muscle between the sacrum and anterior end of the neck. Alternatively, the muscles of the neck were sliced away by careful cutting around the cervical vertebrae. The muscles of the belly were removed from the carcass by cutting along the distal ends of the ribs, with the cuts occasionally being extended to also remove the sternum using heavier chopping tools. The tongue and esophagus were removed from the skull and neck using cuts along the ventral aspect of the neck. The Dassanetch only eviscerate large animals at this point in carcass butchery (Lupo and O'Connell 2002:87). Following removal of the internal organs, the Dassanetch butchers then separated the ribs into groups of three to six, cutting between the groups and either snapping or chopping the rib-vertebral articulations free. The vertebral column itself was then cut or chopped into small sections.

Other researchers (Bunn, *et al.* 1988; Lupo 1993; Monahan 1998:414-418; O'Connell, *et al*. 1988, 1992) have noted consistent variation in these two patterns of carcass butchery that are based on particular prey species or body size. With smaller wild prey, the carcass was sectioned into two parts and the limbs remained attached during transit between the kill-initial butchery site and location of final butchery. Very large animals were routinely field-butchered to an even higher degree. Their limbs were disarticulated and meat was stripped from the long bones. Meat attached to the scapulae was filleted into long sheets. The pelves were stripped of muscle and occasionally split on a sagital plane. Butchery and transport of near-complete game of up to 360 kg (zebra-sized) was possible among the Hadza (Monahan 1998:414-418). Offensive weaponry allowed hunters to protect kills from predators while waiting for carriers to arrive from a residence camp and complete field butchery to occur.

The results of butchery leave deep cutmarks (also noted as slice marks) on long bone epiphyses and near-epiphyseal sections of the diaphyses where connective tissues supporting the joint articulations were severed during dismemberment (Binford 1981). Chop marks in similar locations indicated the use of choppers to cut more resistant connective tissues in disarticulation. Defleshing cutmarks occurred on long bone diaphyses where muscle attachments are severed, both near the epiphyses and mid-shaft (Domínguez-Rodrigo 1997a, 1997b, 2002:17). They also left shallow scrape marks where small amounts of muscle were removed from previously defleshed bones and where the periosteum was removed (Domínguez-Rodrigo 2002:17). Percussion or deep chop marks at muscle insertions indicated use of hammerstones or choppers to sever the connective tissues binding muscles to the bone.

Binford and Bertram (1977:91-93) documented Navaho butchering practices for domestic sheep. Following hide removal from the lower extremities, the next step was the removal of the anterior end of the esophagus, it being tied in a knot to prevent the leakage of stomach contents during the remainder of butchery. The head was then sometimes removed before the animal was hung from a rack for further butchery, with a cut being made from the dorsal surface of the skull and the atlas vertebra. The hanging operation was conducted by making a cut between the tibia and *tensor calcaneum* (Achilles tendon) on both rear legs, through which a rope was passed to lift the animal onto the rack. If not done earlier, the head was removed at this point as detailed earlier.

The sheep forequarters were removed by making an incision along the inner surface of the leg at its juncture with the trunk, freeing the leg from the rib cage. The neck meat was also cut free at this point while the scapula and trapezius muscle are removed up to the vertebral column. Both legs were removed at the same time and were attached by the *trapezius* muscle. Returning to the ventral area previously having the leg-chest muscles removed, a layer of fat was removed from the sternum back to the posterior end of the sternum. Then the sternum was removed with the fat layer by cutting through the cartilage between the rib ends and the sternum.

The sheep's abdomen was butchered starting with a relatively small, incision through the abdominal wall immediately posterior to the diaphragm, the attachments for the viscera were severed, then the abdominal incision extended to the area between the rear legs. This allowed the viscera to be removed as two units; stomach, intestines, and spleen in the first unit to be removed, then heart, lungs, liver, gall bladder, and diaphragm in the second.

Following removal of the viscera, the Navaho butcher cut along the dorsal spines of all thoracic vertebrae to sever the *longissimus dorsi* muscle (loin or backstrap). Then the butcher removed the support from one of the rear legs and chopped through the pelvis to sever the connection to the sacrum and lumbar vertebrae. The chopping cut continued up the vertebral column to sever the ribs as part of the rear leg unit. The next chopping cut removed the caudal vertebrae and sacrum from the other half of the pelvis, extending up the vertebral column to allow it to be removed as a unit from the remaining rear leg unit.

Additional butchering chopped the vertebral column into three or four sections, cut the rib units into three sections, and chop through the diaphyses of the long bones. Following partitioning of the carcass, meat was cut from the bones for use.

Variability in Nunamiut butchering practices observed during the late 1960s and early 1970s were described by Binford (1978). The variability depended on factors that ranged from age of prey, season of kill, and need for vs. ultimate use of the carcasses, to transportation demands (Binford 1978:51-54). Field butchery involved a range of actions from simply eviscerating the prey to complete stripping of the meat from the carcass after it had been sectioned. In many cases, the heads and metapodials were removed to initiate carcass processing, often before skinning. In some cases, carcasses were then cut in half at the thoracic—lumbar transition, sometimes without being skinned. In other cases, the animal was quartered, with the front and rear legs being separated from the axial skeleton before evisceration. The rear legs were removed by cutting through from the ventral side to the acetabulum. Also cutting from the ventral side between the ribs and scapula removed the front legs. Cuts longitudinally down the vertebral column on either side of the dorsal vertebral spines and transversely at the base of the sacrum allowed the *longissimus dorsi* muscle (loin or backstrap) to be removed.

Following evisceration, rib units (third to last) were removed by cutting between the second and third ribs prior to the rib unit being levered up to break the rib-vertebrae articulations, the break being completed by cutting. The brisket meat and sternum was next removed by cutting the cartilage at the rib ends. A transverse cut between the last lumbar vertebra and sacrum separated the sacral-pelvic unit from the vertebral column. The tongue was removed by cutting along the inner margin of the mandible.

A variation of the typical methods reported by Binford (1978: 51-54) left the anterior two ribs attached to the neck unit and the remainder of the vertebral column attached to sacral-pelvic unit and ribs from one side. Butchery methods used by the Inuit to remove meat intended for drying for longer-term storage produced smooth-surfaced meat parcels that were resistant to blue fly larvae resulted in different cutting activities (Binford 1978:95-97). Following dismemberment, the meat was removed from the hind legs as fillets, a procedure that began with the severing of the *tensor calcaneum* at the calcaneus. The flesh of the *tibialis cranialis* and *fibularis tertius* muscles was separated from the caudal surface of the tibia with a series of short cuts. This action also severed the distal attachment for the *vastus lateralis* muscle. Next, a long longitudinal cut was made along the mesial surface of the femur to allow its proximal attachment to be removed with a series of short cuts along the surface of the femur. The articulated remainder of the hind limbs was set aside for further use. The butcher then moved to the fore limbs for a similar filleting action. Beginning at the dorsal surface of the distal radio-cubitus, a transverse cut allowed the distal attachment for the *extensor digiti* and *extensor digitorum communis* muscles to be severed. The next cut, made transversely at the proximal end of the cubitus, severed the distal attachment for the *flexor digitorum profundus* muscle. A follow-up longitudinal linear cut along the mesial aspect of the humerus allowed this muscle to be removed once the attachment at the humerus-scapula articulation was severed with a transverse cut. The meat remained attached to the scapula and was dried in this form.

Dall sheep were butchered in the manner that the Inuit use for caribou that are to be used immediately (Binford 1978:143-144). Following skinning, cuts were made in the crotch area to the ventral side of the acetabulum, loosening the femur-pelvic articulation. The butcher then twisted the hind limb to dislocate the articulation completely. Cutting through the proximal end of the muscle mass covering the femur allowed the rear leg to be removed. The fore limbs were removed by cuts at the anterior aspect of the shoulder joint to loosen the articulation, extending posterior to the margin of the scapula allowing removal. The *longissimus dorsi* muscle (loin or backstrap) was removed in the manner previously mentioned for caribou butchery. Cutting between the costal ribs and distal rib ends from the diaphragm and sternum allowed the brisket meat-sternum unit to be removed. The lungs, heart, and diaphragm were then removed, with the lungs and diaphragm being discarded by burying. A cut between the second and third ribs, allowed a rib unit to be pried loose, with final separation being accomplished by a cut along the rib articulations with the vertebrae. The neck was separated by cutting through the vertebral column at the point where the cut to remove the rib unit ended between the second and third ribs. Another cut was made between the thoracic and lumbar vertebrae, separating the thoracic axial section and a lumbar section with attached sacral-pelvic component with kidneys.

Butchers from the adjacent Inupiat secondarily butchered a caribou carcass following initial field dressing at the kill site that divided it into four parts consisting of the forelegs, the hind legs, the chest cavity and backbone, and head (Chang 1988:153). Field dressing did not include evisceration, but did leave the head at the kill site. Secondary butchery at a residence camp separated the ribs, chest meat, and upper portions of the forelegs, including the scapulae, from the trunk and foreleg units. Further processing removed the entrails, ribs, loin meat, heart, liver, and some fat.

Kent (1993) reported on sedentary hunter-gatherers in Kutse community in the Kalahari region of Botswana. Predominantly Basarwa or San, the community also included Bakgalagadi Bantu-speakers and all of the residents depended on wild game as a major protein source (Kent 1993:326-327). Animals the size of gemsbok or smaller (<240 kg) were initially butchered at the kill site unless the kill happened late in the day, in which case springbok and smaller game were carried to camp before any butchery was done (Kent 1993:336-339). Initial field butchery eviscerated the carcass and removed the skull and distal portions of the limbs, either at the proximal or distal articulation for the metapodials. After the carcass was moved to the residence camp, further butchery disarticulated the tibiae and radii from the more proximal elements of the skeleton and then, if roasted, butchery was completed by chopping and slicing the carcass into smaller units for consumption. This involved chopping rib units out and slicing to remove the forequarter from the carcass, after which the humerus was removed by chopping its articulation with the scapula. The hindquarters were removed as complete units before the neck was separated from the remainder of the axial skeleton by cutting. If the carcass was to be boiled, it was chopped into segments of suitable size to fit the available cooking vessel.

Yellen (1977:286-290) provided some description of !Kung San butchery practices related to the production of biltong or dried meat. !Kung butchers stripped from a kudu carcass meat from all four legs to be dried, together with flesh from part of the back and pelvis. Rib sections, the liver, and the metapodials were also removed from the carcass for immediate use. The rumen or stomach was removed for later use. A tortoise and hare also obtained at the same time were roasted whole and then dismembered.

In addition to hunting, humans also obtain prey by passive or aggressive scavenging from the kills of large predators. This behavior is considered to have been potentially important in human evolutionary history. It has also been termed early and secondary access scavenging, with human confrontation of carnivores being a major difference between the two methods (Cavallo and Blumenschine 1989; Domínguez-Rodrigo 2001, 2002:15). Modern hunter-gatherer populations used the practice of confronting carnivores (Bartram 1993; Blumenschine 1986; Blurton Jones, *et al*. 1989, 1996; Domínguez-Rodrigo 1994; Hawkes, *et al*. 1991; Gifford-Gonzales 1989a:184-185; Klein, *et al*. 1999; Lupo 2001; Lupo and O'Connell 2002). Carcasses scavenged from felid kills provided Dassanetch hunter-gatherers with either entire anatomical units, such as a hindquarter or forequarter, or just the meat and sinews (Gifford-Gonzales 1989:184).

Blumenschine (1986, 1988, 1989, 1991, 1995) provided a significant advance in the knowledge of the limits of potential opportunistic scavenging, based on work in Africa with canid, hyaenid, and felid predators. His conclusion was that secondary access to carnivore kills only provided abundant meat in the case of felid-killed prey because the other carnivores were more social and consumed prey more thoroughly and at a faster rate. The consumption behavior of many species of felids seemed to leave an opening for humans to obtain portions of a carcass from a kill either by scavenging from a cached kill or by driving off the predator while it was consuming the carcass (Cavallo and Blumenschine 1989). Larger, more social felid species were less likely to be driven from a kill without overwhelming threat of force by humans possessing offensive technology, such as the bow and arrow (Lupo and O'Connell 2002:105).

Marrow Procurement

Mammal bones contain stores of fat in two forms, bone grease in cancellous bone within the axial skeleton and long bone epiphyses and marrow found in the medullary cavities of long bones (Outram 2001:401). Various wildlife management researchers (Brookes, *et al*. 1977; Cheatum 1949; Davis, *et al*. 1987; Peterson, *et al*. 1982) have noted that the fat stores within the bone are the last to be metabolized by the animal. They are the most reliable source of fat for a hunter securing game. The sequence of fat depletion within the appendicular skeleton has been well studied in ungulates (Blumenschine and Madrigal 1993; Brookes, *et al.* 1977; Speth 1987, 1989, 1991a). Based on this research, fat stores in ungulate proximal limb bones are depleted first for metabolic use and the distal elements of the forelimbs are the last to be mobilized.

Speth (1983, 1987, 1991b; Speth and Spielmann 1983) established the nutritional importance of animal fat in cases where access to carbohydrate sources is limited. Kutchin and Copper Eskimo hunter-gatherers of North America were aware of the seasonal need for sufficient fat intake to ward off the adverse effects of over-consumption of lean meat protein in the diet. The caloric value of animal fat is much higher than animal protein or carbohydrates. Fat also contains fat-soluble nutrients (Erasmus 1986; Mead, *et al*. 1986). Indigenous hunters in both tropical and temperate climates preferentially chose quarry with a higher potential for a higher fat content, sometimes to the exclusion of other high-calorie foods (Speth 1983:146, 1987, 1989, 1991a; Stiner 1991, 1994). Exploitation of bone fats by indigenous hunters has been corroborated by others pursuing actualistic research among the North American Nunamiut Inuit (Binford 1978), South American Ache (Hill, *et al*. 1987, Hill 1988), !Kung San of southern Africa (Yellen 1991; Kent 1993), Dassanetch and Hadza of eastern Africa (Blumenschine 1986, 1988, 1991, 1995; Blumenschine and Selvaggio 1988, 1991; Bunn, *et al*. 1988; Gifford-Gonzales 1989a; Lupo 1998, 2001; Lupo and O’Connell 2002; O’Connell, *et al.* 1988. 1990, 1992), and Australian Alyawara (O’Connell and Marshall 1989).

Energy value alone is not the only consideration with animal fat as a resource because other factors, such as macronutritional constraints and social factors, also affect any decision to use it (Lupo 1998:663). Lipids in animal fat are indispensable for certain segments of any population. This is especially true for females during pregnancy and post-partum lactation (Hill, *et al.* 1987; Hill 1988). During childhood development, animal-derived long-chain polyunsaturated fatty acids are quickly metabolized and incorporated into the brain's structural. Fat has also traditionally had many other uses, among them waterproofing skins, treating bowstrings, tanning hides, and lighting (Binford 1978:24; Burch 1972; Levin and Potapov 1964:636).

Zooarchaeological and ethnoarchaeological actualistic studies of marrow procurement have followed two parallel lines of investigation. The first documented the fat content characteristics of potential prey animals. The second line of investigation documented the marrow processing behavior of indigenous hunter-gatherer groups.

Lupo (1998) reports the characteristics and caloric variability for African wild ungulate marrow and brain fat reservoirs. In the study, seventeen carcasses of medium-sized artiodactyl (impala, hartebeest, wildebeest) and perrisodcatyl (zebra) taxa were experimentally butchered, marrow was extracted from limb bones and mandibles, and the nutrient contents and average extraction time for meat, marrow, and other tissue determined (Lupo 1998:659-664). In the results, perrisodcatyl (zebras) were reported to have much less marrow in the legs than artiodactyls (Lupo 1998:660). The reduced marrow capacity in equid limb bones is directly related to the anatomical structure and their locomotor function (Blumenschine and Madrigal 1993). The proximal limb bones (humerus, femur, and tibia) of all species investigated had larger amounts of marrow and were more easily processed than other limb bones or the head (Lupo 1998:Tables 5 – 12). From the appendicular elements assayed and reported by Lupo (1998:Tables 2, 6), the impala yielded 110 – 146 g of marrow (120 - 1272 kcal), the wildebeest 430 – 440 g of marrow (460 – 3940 kcal), the hartebeest 210 – 376 g of marrow (228 – 1828 kcal), and the zebra 135 – 171 g of marrow (150 – 1300+ kcal).

Outram and Rowley-Conwy (1998) produced economic utility indices for horsemeat and marrow, based on butchery of several horse carcasses. Because the carcasses were obtained from a rendering plant, the carcass weights of 168 to 268 kg did not include viscera, skin, or blood, but were dressed weights only. The results corroborate those of Blumenschine and Madrigal (1993) concerning the reduced marrow yields from equids in general. The horse was actually being lower than the zebra. Outram and Rowley-Conwy (1998:Figures 7 and 8) graphically portray how trabecular bone in the horse's upper limb bones significantly reduces the medullary cavity volume and total marrow yield. They also report that much of the marrow from horses is in the form of linoleic and linolenic acids, relatively liquid polyunsaturated fatty acids. The average marrow yield from the three horses used in this study was approximately 230 grams, almost 30 percent of which comes from the femur. The humerus, mandible, and tibia also yield significant amounts of marrow in horses. The excessive trabecular bone in the medullary cavity of the limb bones and extremely dense cancellous bone of their diaphyses make marrow recovery difficult.

Hockett and Bicho (2000) investigated lagomorphs and quantified the marrow contents of long bones of European rabbit and Iberian hare. They noted that the jackrabbit-sized hare would contain approximately 7 grams of marrow, while the cottontail-sized rabbit would contain approximately 3 grams of marrow.

Madrigal and Capaldo (1999) collected data on marrow yields of seven white-tailed deer from the eastern United States. They included marrow recovery at least partially using hammerstones in experimental butchery. The results showed seasonal variation in the energy yield from this sample of primarily young female deer (only one adult female and one subadult male deer in the sample). Madrigal and Capaldo's (1999:243-245) results also revealed that the tibia of this taxon has the highest marrow yield, with over twice the amount of the next highest element, the femur. All of the other limb bones provide considerably less marrow. The total marrow yield for the adult female white-tailed deer was in excess of 1060 kcal, based on a dry weight of over 121 grams of marrow (Madrigal and Capaldo 1999:Table 2). The much larger subadult male provided a higher amount of marrow, even though it was under some nutritional stress at the time of death. Madrigal and Capaldo's (1999:244) results corroborate the sequential fat depletion of the proximal limb bones prior to the more distal elements.

Ethnographic research by ethnoarchaeologists in Africa, Australia, and the Americas examined the marrow-recovery procedures used by indigenous peoples for a range of mammalian prey (c.f. Binford 1977, 1978; Bonnichsen 1973; Gifford-Gonzalez 1989; Jones 1983, 1984; Kent 1993; Lupo and O'Connell 2002; O'Connell and Marshall 1989; O'Connell, *et al.* 1992; Zierhut 1967). Research among the East African Dassanetch showed several situation-dependent methods of marrow recovery (Gifford-Gonzalez 1989:186, 196-200, 211, 214, 216, 218). In residential camps, long bones were roasted to either cook attached meat (proximal limb segments) or the marrow itself (metapodials) and then broken with hammerstones and anvils afterwards, especially with larger bovid or zebra specimens. Alternatively, long bone segments were treated in the fashion of vertebral or rib segments and boiled, then broken open to remove the marrow. Both anvil and hammerstone were used to fracture the elements in mid-diaphysis to remove the marrow. In foraging camps, long bones were fractured prior to cooking and, in the cases of large bovids, much closer to the epiphyses.

Among the Hadza, (O'Connell, *et al.* 1988:118; Lupo and O'Connell 2002:87-89) documented the mid-diaphysis breakage of marrow bearing long bones using hammerstones and consumption of marrow at intercept or encounter butchering stands and kill or "snack" sites, if the bones had been fully defleshed there. Similar actions were taken when bones were defleshed at residential camps. The periosteum was not removed from the bones.

For small animals, the San of southern Africa warmed bones before smashing or chopping the epiphyses away (Kent 1993:338; Yellen 1991). Once the marrow cavity of a long bone was heated and opened, its liquefied contents were then sucked out. In some cases, the marrow of smaller animals was not harvested separately, but was included in cooked carcasses being chopped and shredded before consumption (Kent 1993:342).

The Aché of eastern Paraguay in South America used a similar technique to obtain the marrow from small mammals long bones (Jones 1983, 1984). The articular ends were either chewed or broken off and then the marrow was removed for consumption.

Zierhut (1967) reported Calling Lake Cree butchery of the largest North American cervid, the moose, in the Canadian province of Alberta. As documented by Bonnichsen (1973:9-13), based on Zierhut's research, the Cree butchered moose carcasses in a traditional pattern modified by the use of steel cutting tools, especially heavier ones such as the ax. Cree butchers removed the head by chopping before the neck was partitioned into several segments by chopping. Following removal of the head, the skull was transversely cut in half at the base of the muzzle by ax blows that opened the cranial cavity, allowing the brain to be removed. The processing allowing access to marrow cavities in the maxillary was done by chopping to remove the orbits and nose, then by splitting the nose and palate longitudinally. The inferior border and anterior end of the mandible was chopped off or struck with blows from the blunt end of the axe head to gain access to the mandibular marrow cavity.

The proximal appendicular skeletal elements of the moose were also harvested for marrow after being heated on an open wood fire. The periosteal sheath was burned away in the process. In the process of being broken to obtain marrow, each element was supported by stone anvils placed under the epiphyses. An axe was used to strike the diaphysis, shattering it into at least two portions. The marrow was then removed with a small stick. Alternative materials sometimes included log anvils, hammers, formerly hammerstones.

Also in North America, Binford (Binford and Bertram 1977:94-95; Binford 1978:145-149, 152-164) studied marrow harvesting among the Nunamiut Inuit in the Canadian Arctic and the Navaho in the arid southwestern United States. He found that the Navaho formerly harvested marrow from the bones of game or domestic stock (Binford and Bertram 1977:94-96). The Nunamiut were observed to harvest marrow using several methods (Binford 1978:145-149, 152-164). They expediently fractured bones in mid-diaphysis at kill sites and temporary camps to “snack’ on marrow. The bone to be fractured was placed near a fire to warm and in the case of unskinned metapodials, to singe the hair off. Once the element had been warmed, remaining skin, soft tissue, and periosteum was removed by cutting and scraping and the bone was stuck with a blunt object to fracture it. Objects documented by Binford (1978:153) to be used to fracture bones for marrow removal included handles of butchering tools and articulated metapodials. Proximal appendicular elements such as the humerus and femur had the epiphyses removed similarly before the marrow was extruded. The two epiphyses and resulting bone cylinder or fragments of the diaphysis were saved for later use in bone grease rendering. The same method was used in Nunamiut base camps. Diaphysis fracture was never done with the element supported by anvils (Binford 1978:153). The element was held unsupported and struck in the manner that a flint knapper would strike a core or tool being manufactured. The butchering methods for the caribou or Dall sheep skull chopped or smashed open the marrow cavities in the skull and mandible. The brain and fat in the muzzle were also made available for use.

Bone Grease Procurement

Researchers investigating bone grease procurement have also followed two parallel lines of investigation. The first documented the non-marrow, in-bone fat characteristics of potential prey animals through actualistic research. The second line ethnographically documented the bone grease processing behavior of indigenous hunter-gatherer groups.

Brink (1997) and Emerson (1990) investigated bone grease in modern North American bison. The importance of the in-bone fat resources of this species was recognized when Euro-Americans first encountered indigenous North American hunter-gatherer cultures. Vehik (1977) and Brink (1997:260, 272) provide an excellent review of indigenous bone grease rendering methods reported in ethnohistoric and ethnographic accounts from the 19th and 20th centuries.

Brink (1997:260- 264) analyzed the in-bone fat characteristics from the limb bones of three northern *Bison bison*. Two of these were harvested in late fall from a relatively free-ranging herd in a Canadian national park. The other was from a herd intensively managed for commercial meat markets, was grain-fed like cattle, and was harvested in spring. A total of 54 bone samples were collected from the humerus, radius-ulna, metacarpal, femur, tibia, and metatarsal of each animal. The portions of each bone sampled included the proximal and distal epiphyses and midpoint of the diaphysis, exclusive of the marrow. Samples were crushed, oven dried, and homogenized; then grease was extracted using petroleum ether. Once the ether residue evaporated, weight and percentage of chemical fat results were calculated on a dry weight basis for each animal with a mean derived for the group.

Brink's (1997:262-263) analysis verified the grease content variation within elements, with a wide variety of fat content in the elements sampled. Of the proximal skeletal elements, the proximal ends generally have a higher amount of fat than the distal ends. The dense cortical bone of the proximal skeletal elements diaphyses has a much lower fat content. Of the four proximal skeletal elements of the bison (humerus, radius-ulna, femur, and tibia), the humerus had the highest percentage of fat, with a mean of 40.5%, and also the greatest amount of fat, 324 g. Most of the proximal skeletal elements had bone grease content of 30 – 35% proximally (mean weight of 110 – 129 g). The distal ends vary more, with a range of 14 – 35% grease content (18 – 256 g). The metapodials' fat content varies in a inverse order, with the distal ends having a higher fat content than the proximal aspects. The metapodials also have a much lower bone grease content, between 7 – 9 grams proximally and 26 – 36 g.

Emerson's (1990) extraction method differed, with boiling of whole bones being used instead of chemical extraction from the crushed, differentiated portions that Brink (1997) used. Brink (1997:268) notes that the boiling process used by Emerson (1990) more approximates techniques observed historically and would recover an amount more approaching that done by indigenous American practitioners. Field experiments by Brink, *et al*. (1986), using a stone boiling method in bison hide-lined pits that approximates the ethnohistorically-observed methods, found grease lost during heat extraction to be considerable. However, the differential bone grease production per segment of skeletal element should correspond to his results (Brink 1997:268).

Research by ethnoarchaeologists in Africa, Australia, and the Americas examined the bone grease rendering procedures used by indigenous peoples for a range of mammals (Binford 1977, 1978; Bonnichsen 1973; Gifford-Gonzalez 1989; Kent 1993; Lupo and O'Connell 2002; O'Connell and Marshall 1989; O'Connell, *et al*. 1992). The African pastoralists and hunter-gatherers studied by these researchers all live in warm tropical or subtropical climates. The warm climate in which the San live precludes long-term storage of bone grease because it will become rancid (Kent 1993). Bone grease production on the scale practiced in colder climates is not attempted. Cancellous articular ends of bones are added to stews and broths where the rendered fat enriches taste and adds fat to the diet. Binford (1978:163-165) terms this the manufacture of bone juice and notes that it is commonly used where freshly killed animals are introduced into residence camps for immediate use, especially if weather conditions would hasten fat becoming rancid. It often includes the ribs, especially if made away from a residence camp, but may include pulverized articular ends of long bones. The Dassanetch typically segmented carcasses into pot-sized units for boiling to cook meat and to prepare broths (Gifford-Gonzalez 1989:186, 196-200). Similar behavior was also found among the Hadza who consumed cancellous tissue gouged out of the epiphyses and ribs (Lupo 1993, 1995; Lupo and O'Connell 2002:87).

In temperate climates, bone grease need not always be limited to immediate use because it will not go rancid as quickly and may be stored for long periods of time. Perishable items placed within grease will be protected against spoilage because the grease protects them from oxidation because it seals out oxygen. The Canadian Cree processed bone grease from moose carcasses by removing the proximal epiphyses of the humerus, chopping ribs into small sections, and removing the neural spines from thoracic vertebrae to be chopped into small sections similar to ribs (Bonnichsen 1973:11). The blade portions of the pelvis are also removed for a similar use. The fragments from these bone segments were chopped into smaller sizes on an anvil and then added to boiling water in a container. The fat in the cancellous bone was melted and floated to the top of the liquid to be skimmed off. Older members of the Cree remembered the use of hammerstones before the widespread availability of metal axes (Bonnichsen 1973:11).

In Nunamiut base camps where full-scale grease production was practiced, the epiphyses were fractured and pulverized before being boiled in water. Heat melted the grease from within the bone and allowed it to float to the top of the liquid where it was skimmed off and cooled for later use (Binford 1978:145-149, 158 - 164). Another less intensive method was to add smaller amounts of crushed bone to hot water to produce a broth or bone juice. Diaphyses fragments retained after harvesting of marrow were often boiled to remove residual bone grease.

II: CURRENT RESEARCH ANALYSIS AND RESULTS

Chapter 4: Methods and Materials

BRIEF DESCRIPTION OF ARCHAEOFAUNAL AND BONE ARTIFACT ASSEMBLAGES

The 1965-68 excavation of Arenosa Shelter by University of Texas at Austin crews was described in Chapter 2. Excavation of controlled, individual units totaled approximately 1460 ft^2 in three blocks within the site. These excavations were conducted at a time when archeologists were making a transition to finer mesh size to screen removed fill. In the first of the three blocks, excavated in 1965-66, crews used 0.5-inch mesh screens. The other blocks were screened using 0.25-inch mesh hardware cloth, resulting in greater recovery of smaller items.

The upstream block was excavated in 1966-68. It included a 440 ft^2 area on the upper terrace between the shelter's drip-line at N200/W160 and its back wall. The upstream block also included units outside of the shelter, on the terrace slope leading down to the Pecos River between N180/W160 and the upper terrace surface. The portion of the upstream block within the shelter overlaid the most deeply excavated portion of the site. The stratigraphy within the upstream block contained nearly all of the site's defined strata. It was the least disturbed portion of the site, although the block's stratigraphy also exhibited evidence of flood damage. The unit size used in this block was smaller than that in the other two blocks, primarily 5x5 feet in stratum 37 and above. The lowest portion of the site contained strata 38 – 42 and included six units between N199/W167 and N214/W195. This area encompassed three 5x8 feet units and Pits D, E, and F. These lower strata predated 9,550 radiocarbon years before present, the uncorrected ^{14}C date from Stratum 38 in Pit D.

The upstream block was excavated using a more stringent recovery method with finer controls over the excavations than that used in the other blocks. The more stringent controls resulted in more accurate provenience for all materials recovered within the block. Based on the author's initial physical examination of the TMM-VP research collection, this area also had the best bone preservation found within the site. For these reasons, faunal materials from the upstream excavation block were determined to be the best sample to use for the current research.

Full-scale analyses of all collections from Arenosa Shelter were never completed, but as indicated in Chapter 2, Bement (1991) and Collins (1974) analyzed lithic specimens from the Arenosa Shelter collections. These researchers examined the statistical typology of an Archaic projectile point type and the lithic technology used at the site to manufacture a variety of tool types, including Archaic and Late Prehistoric projectile points. Collins (1974:341-352) documented the use of soft-hammer percussion and pressure flaking in the lithic technology from Arenosa Shelter, based on evidence in the lithic assemblage. He also suggested that bone or antler implements might be present among bone artifacts from the site that were used in such roles. Also, Collins (1974:570-572; December, 1999:personal communication) notes the presence of wedge-shaped, backed unifaces in the lithic assemblage that may have functioned to cut fiber or bone in manufacturing items in these technological system subsets.

Based on his first two of four field seasons at Arenosa Shelter, Dibble (1967:63-71) provided a short summary of the vertebrate faunal remains from the site in a preliminary report to the National Park Service. His preliminary description of the assemblage indicated a wide variety of cultural materials excavated from the site that included archaeofaunal specimens and artifacts of bone or antler. The 1967 report defined several categories of "worked" bone or antler artifacts. Dibble's (1967:63-64) type definitions including several forms interpreted as beads, awls, split-bone needles, and notched or incised bone implements. It also noted the large number of archaeofaunal specimens and differential preservation that reduced the survival of bone in the lower strata. Dibble (1967:63) recognized the strong potential to greatly increase "the ultimate interpretive potential of the site" during the excavations.

Subsequent NPS and NSF-supported cataloging and re-inventory identified over 47,000 objects or fragments of bone in the collections from Arenosa Shelter. This total included many bone artifacts. Almost 1,000 complete or partial items generally corresponded to Dibble's (1967) initial description of the bone-based cultural assemblage from 1966. The bone artifacts were housed in the TARL research collection. Items listed as awls, beads, bead preforms, polished bone, modified catfish spines, modified deer antler, painted bone, and grooved or incised bone were recorded in the ANCS II database at the beginning of the current study. Approximately 200 beads and over 500 awls were listed in the inventory at the beginning of the current research. Several different forms of both awls and beads were noted in the catalog. Many more bone fragments housed in the TMM-VP research collection exhibit cultural modifications such as burning, impact fractures, polish, and cutmarks.

The vertebrate species represented in the site's collection inventories when the current study began included birds, fish, reptiles, and amphibians, but were primarily mammals. Remains of many small to medium mammal species were predominantly rabbits and deer. Small to medium-sized rodent and carnivore remains were also present. Larger mammals included both modern and extinct species of bison. Birds included waterfowl and terrestrial species. Fish were represented by a variety of sizes and species with potential economic importance, such as catfish, gar, and several cypriniform suckers.

Within the upstream block, the more protected area inside of the shelter had characteristics warranting more intensive examination of its archaeofaunal material as a sample for the current research. This protected area included excavation units overlying the deepest excavated portion of the site. A total of 340 ft^2 was excavated within the upstream block's upper strata between the N180/W160 and N210/W184 grid points. The lower portion of the upstream block was excavated in an L-shaped area that included six units sampling strata below Stratum 37 between N199/W167 and N214/W195, an area of just over 200 ft^2 (Figure 10). Based on a thorough examination of field records archived in TARL's Records Section, the sampled area was known to contain 85 lots recorded as containing bone, slightly more than 20 per cent of the 404 bone-containing lots. Physical examination of the archaeofaunal material from the sample area in TMM-VP's research collection showed it to be varied in condition of preservation, but generally better than much of the bone from less protected

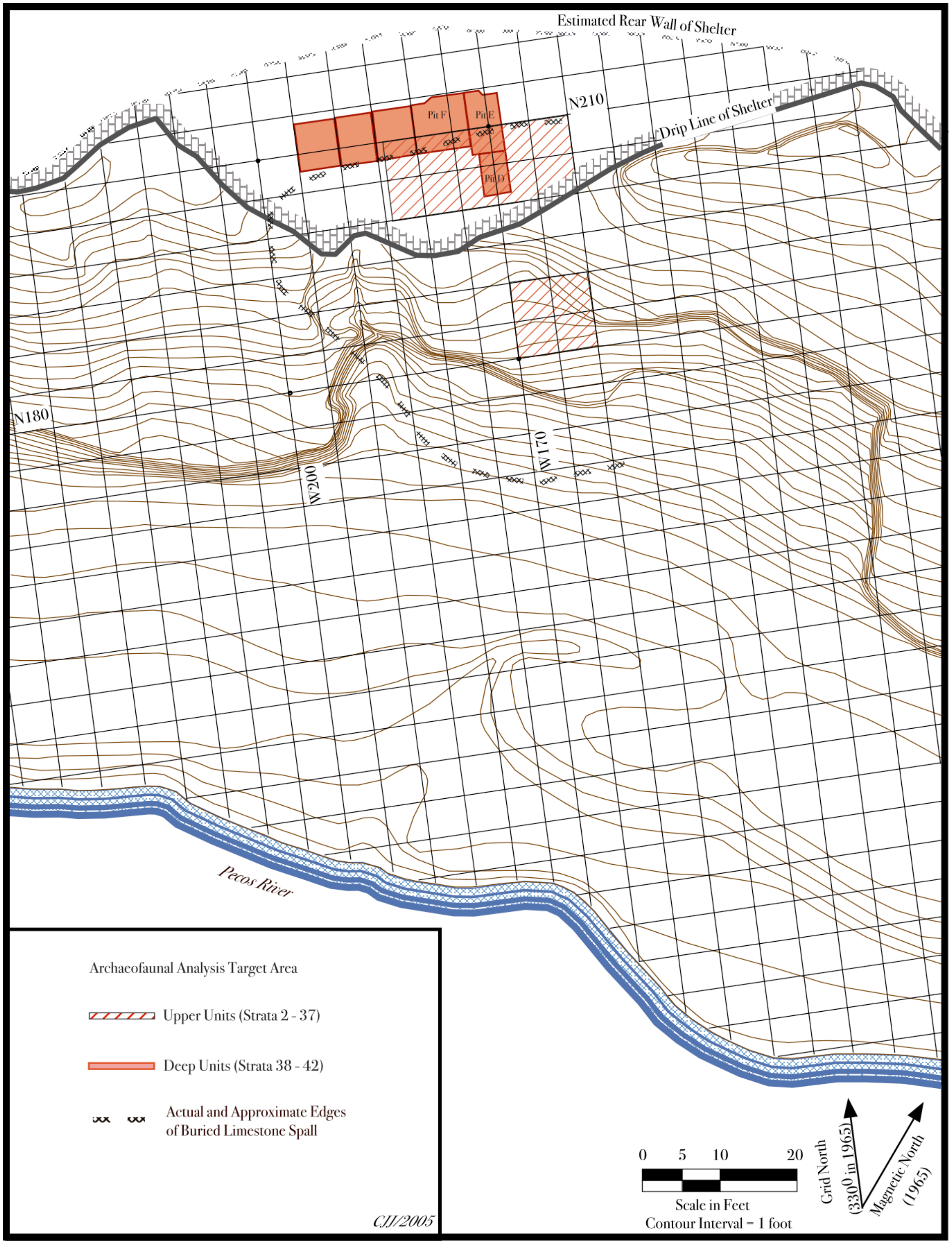

Figure 11: Arenosa Shelter (Site 41VV99) Archaeofaunal Analysis Target Area

portions of the site. While the sampled area was also known from Dibble's field records to have experienced the harmful effects of scouring during episodic major flooding, most of the site's defined strata were present within it. As research progressed, the author became acutely aware of contextual limitations imposed by the site's depositional history. As a cautionary note, readers should refer back to discussion of applicable previous geological research in Chapter 2 and stratigraphic description in Tables 2.1 and 2.2 to refamiliarize themselves with the harmful effects of erosion on the site's contents and their context, especially in strata below Stratum 18. The effect of contextual limitations within the site is strong and significantly affected the presence and preservation of archaeofaunal material. The sampled area showed the least damage even though it, too, was affected by erosion associated with river flooding. Even with these limitations, the archaeofaunal sample from Arenosa Shelter is among the best from the Lower Pecos region.

Thus, the sample selected for detailed examination during the current research was chosen from the portion of the site with the best stratigraphic record and the best bone preservation. Due to a number of factors, it had the strongest potential of the site's archaeofaunal contents to allow the most complete examination of the current research's fundamental aims.

METHODOLOGY

The current examination of Arenosa Shelter archaeofaunal materials was conducted to expand upon previous material culture analyses. The methodology was designed to fully define the characteristics of the site's vertebrate faunal assemblage by closely examining a sample of the Arenosa Shelter archaeofaunal collections and bone artifacts.

As an important first step, the remains of vertebrate species present in the sample area described previously were to be identified and quantified, including those documented as prey of the site's prehistoric human inhabitants obtained for food or other uses. Secondly, the study methodology was planned to detect and record evidence for processes used to manufacture bone or antler tools and ornaments during the region's long occupation. By these means, the study methodology was to identify and describe the mechanisms and cultural modifications through which bone from prey species was incorporated into the Lower Pecos technological system as a raw material.

Unmodified Bone

Animal carcasses found in archaeological sites may enter the fossil record with no obvious indication of cultural modification or manipulation. Arenosa Shelter's topographic location within an alluvial terrace of the Pecos River canyon had relatively good availability of water, an important resource. Due to this location, the site is within the woody vega-terrace vegetation unit defined by previous botanical researchers. This unit contains relatively large-scale vegetation--brush and mesquite, willow, sycamore, pecan, live oak, and mulberry trees, an oasis in an otherwise arid environment. As such, the site's physiographic situation would have provided an attractive, sheltered woodland habitat during its long cultural occupation concurrently to both the prehistoric human inhabitants and a wide range of terrestrial vertebrate animals.

The site's demonstrated habitation use by terrestrial animals and potential use as a roost area by predatory birds allows additional agents introducing animal carcasses into the fossil record. Those not definitely introduced through human agency could have entered the fossil record through natural death or accumulations of prey remains. Bones reflecting no obvious cultural modification or manipulation were assumed to originate from naturally introduced animal carcasses. Bones lacking physical evidence of burning, cutmarks, impact damage, or remnant of culturally-derived disposal such as bone stacking recorded in the project's field notes were anticipated to be reflected in remains originating from non-cultural deposition. Similarly, animal carcasses associated with flood deposits would probably not reflect cultural association except through potential scavenging or mixing. Based on this assumption, a methodology was developed to enable the author to address paleo-environmental reconstruction needs using remains that lacked obvious cultural modifications or manipulations. The archaeofaunal materials from the study's target area represent a statistically significant sample of the over 47,000 bone fragments collected during four field seasons of excavation at the site.

During several decades of curated storage, the Arenosa Shelter archaeofauna had not previously been prepared for study. As a result, the current study's methodology included initial cleaning of all bone fragments. Water and gentle scrubbing using small artists brushes and bamboo splints was used to remove adhering sediment. Where necessary to make the surface of bone fragments visible, the methodology incorporated standard vertebrate paleontological preparatory techniques to remove calcium carbonate encrustations. A short-duration soak in a dilute (10%) solution of acetic acid was to be used for this purpose. Following use of acetic acid, specimens were soaked in water and air-dried. Fragile fragments were then consolidated with a solution of polyvinyl acetate (PVA, brand-name *Gelva*) diluted in acetone. Specimens were also examined microscopically using a binocular dissecting microscope at a magnification of 10x – 30x and then cataloged separately, if needed.

Species Determination

The species determination methodology developed for the Arenosa Shelter archaeofaunal study incorporated classificatory practices from vertebrate systematics. An assessment of taxonomic differences between skeletal materials from recent, sub-fossil, and fossil organisms must be based on remaining hard tissues. The methodology used with the Arenosa Shelter faunal collection was designed to make taxonomic identifications using standardized anatomical methods from veterinary anatomy, zoology, and vertebrate paleontology. These particular methods use morphometric differences in remnant hard tissues, such as teeth, bone, antler, and shell, to phenotypically classify organisms into the Linnaean hierarchical classification system. The TMM-VP modern comparative osteological and fossil locality collections were used as primary aids in determining taxonomic assignments for individual specimens in the Arenosa Shelter archaeofaunal collection. Specimens from Arenosa Shelter were identified to the appropriate taxonomic level, based on size and visual characteristics of elements from specimens of known taxa from the TMM-VP collections. Veterinary anatomy and taxon-specific zoology texts were consulted to determine appropriate anatomical characteristics for distinguishing between species of catfish, ruminants, carnivores, rodents, and lagomorphs. Where necessary to determine anatomical characteristics or to ascertain specific damage by carnivores, low power microscopic examination of specimens used a binocular dissecting microscope at a magnification of 10x – 30x.

Age and Sex Determination

The methodology developed to examine the age composition of the Arenosa Shelter archaeofaunal collection was based on existing methods from zoology and vertebrate paleontology. These methods use visual characteristics to assign vertebrate skeletal material to approximate age classes of fetal, juvenile, sub-adult, or adult, based on size and morphology. Morphological characteristics used included tooth wear, the surface texture and other physical appearance of the bone structure, fusion of bone sutures, and presence of deciduous or permanent dentition. Other more specific methods were used for fish. Although not as applicable to warmer waters, annual growth cycles leave distinctive growth structures termed annuli that may be counted. Use of this method allowed a more accurate determination for some of the fish specimens. While similar growth structures are found in mammalian teeth and several bony other tissues in fish, most of these annuli are only detectable using invasive, techniques that require cross-sectioning of the elements. The Arenosa Shelter methodology specifically was developed to allow use of non-invasive optical methods to detect and record annular growth structures in fish vertebrae.

Enumeration

Enumeration of archaeofauna may be based on both observational and analytical units, such as NISP, MNI, MNE, or MAU, as discussed in Chapter 3. The methodology adopted for use during the current study enumerated numbers of elements or fragments of elements, identified to most appropriate taxon and differentiated by side and age, where possible. NISP was derived for each taxon, differentiated by horizontal and vertical excavation units used by the excavators. MNI and MNE were derived to allow for identification of the number of individual animal carcasses represented in the Arenosa Shelter study collection, distinguished on the basis of anatomical and age characteristics. As recommended by Lyman (1994a:104), the MNE measure used in this study was specified to include diaphysis fragments. The degree of fragmentation in the collection was assessed using a comparison of NISP, MNI, and MNE.

Culturally Modified Bone

Animal carcasses with obvious indications of cultural modification may also enter the fossil record in archaeological sites. Physical evidence of cultural modifications and manipulations were anticipated to be reflected in remains originating from cultural deposition. This would include burning, cutmarks, impact damage from fracturing for marrow retrieval or grease production, or remnants of culturally derived disposal such as bone stacking recorded in the project's field notes. Based on this assumption, a methodology was developed to enable the author to address cultural faunal processing aspects of the study using remains with obvious cultural modifications or manipulations.

Subsistence-Related Faunal Processing

Lyman (1987a:252, 1994a:295) reasoned that osteological components produced during butchering should be archaeologically visible as results of an extraction process yielding muscle, skin, and fat products. This reasoning guided development of the methodology for recognition and analysis of the Arenosa Shelter culturally-modified archaeofauna. The methodology for recording and assessing heat-related discoloration possibly associated with cooking or bone disposal takes into account Shipman, *et al.*'s (1984b) cautions concerning culturally-related heat damage in recording the anatomical position, intensity, and frequency of burning, although high power microscopy was not used. Given that grass fires in semiarid areas don't achieve the heat intensity or duration necessary to alter the color or structure of bone (cf. Shipman, *et al.* 1984b:323), it was assumed that heat damage was culturally induced. Overall burning was assumed to indicate bone disposal, with partial burning indicating bone insulated by meat during roasting. General degree of color change was noted for burned bone, but not rigorously assessed. Shipman, *et al.*'s (1984b:313) burning stages and resulting bone color was used as a guide in assessing degree of heat damage.

The means for detecting and recording butchering activities necessary to disarticulate, skin, and fillet meat from animal carcasses were adapted from standard zooarchaeological methods currently in use. Cutmarks resulting from butchering are grouped in locations that impact a specific biological structure on butchered skeletal elements, such as a muscle insertion or articulation (Shipman and Rose 1983a). Trample marks are not grouped in the same manner and do not show similar parallel micro-striations within the marks' narrow, approximately V-shaped cross-sections. Chop-marks are deeper and wider in profile, but shorter in length than cutmarks resulting from slicing actions. They also occur in anatomical areas that had more resistant connective tissues present, such as articulations (Binford 1981).

Following Binford (1981:47), the study methodology defines skinning to leave cut-marks on distal portions of the extremities, the lower margins of the mandible, and on the skull. Disarticulation chop- and cut-marks are limited to articular surfaces of long bones or along their edges, and on the surfaces of vertebrae and portions of the pelvis. Filleting or meat removal leave cut-marks transverse to the long axis of some skeletal elements at the insertion points for muscles, parallel to the long axis of some skeletal elements, or in the case of fish, parallel to the long axis of larger anatomical units such as the vertebral column. Hammerstone blow marks at appropriate anatomical positions, such as the insertion points for muscles (cf. Domínguez-Rodrigo 2002), were included as evidence of a defleshing method. Stress on blow locations allows impact damage from roof fall within the shelter to be separated from cultural alteration. The study methodology also distinguishes between primary butchery, secondary butchery, and final butchery-consumption, *sensu* Lyman (1994:300).

Use of low power (10x – 30x magnification) microscopic examination of specimens employing a binocular dissecting microscope and low-angle directional lighting was used to detect and record cut-marks, chop-marks, blow-marks, and any carnivore damage which might also be present. The methodology also included an analysis of the Feature 18 cultural feature to determine whether bone stacking reported elsewhere for Paleoindian occupations might be deduced from field notes.

Also incorporated into the methodology for assessing culturally-related faunal processing was detection and analysis of fragment surface damage and fracture patterns to determine the frequency and characteristics of those most likely to be caused by fracture-based cultural behaviors. Following Johnson (1985:175, 192), fragment surfaces were examined using low power (10x – 30x magnification) microscopic examination employing a binocular dissecting microscope and low-angle directional lighting to detect and record blow-marks, notching, ring-cracks, crushing, or other fracture features. The microscopic examination was used to detect any scoring and pitting damage from carnivore mastication that might also be present. The examination also recorded the weathering state at which fragmentation occurred, using characteristics advanced by Shipman, *et al*. (1981). MNE vs. NISP calculations were derived to assess the overall degree of fragmentation represented by the collections.

Technology-Related Manufacturing and Use Modification

The methodology developed to study manufacturing of bone artifacts and modifications caused by use of those artifacts complemented the methodology used for studying fracture-based bone fragmentation. Following soaking in water and air-drying, each artifact was thoroughly cleaned under 10x – 20x magnification by gentle scraping with a bamboo splint, dental scaler, or brushing. Final dusting with compressed air was used to clean the surfaces for analysis. Where necessary, a short-duration acetic acid (10% solution) bath was employed prior to water-soaking to enable calcareous encrustations to be removed.

Time limitations required sampling to reduce the number of artifacts for analysis by approximately 50% prior to analysis while still being able to produce valid results. From the collection of approximately 1,000 artifacts, artifacts were chosen that reduced redundancy within strata and time units. This emphasis facilitated efficient use of analytical efforts by securing a diverse sample with which to document the breadth of artifact types, manufacturing methods, and use-wear characteristics through as much of the site's occupational history as possible. The sampling strategy was judgmental. The author used a combination of factors that were based on a thorough knowledge of the excavation and recovery methodology used at the site, its stratigraphy, and the physical contents of the resulting artifact collection and its characteristics.

The analysis methodology involved specimen examination using low power (10x – 70x magnification) microscopic inspection. A binocular dissecting microscope and low-angle directional lighting were employed to detect manufacturing features, such as impact fractures, grooves or cutmarks, and grinding, which were recorded prior to analysis of attributes. Polish and burning that related to subsequent use or discard were also recorded for items subsequently incorporated within the site's matrix. Both manufacture and use wear characteristics were recorded using standardized signatures reported in the bone technology literature (cf. Griffits 2001; Griffits and Bonsall 2001; Lemoine 1995, 1997).

Chapter 5: Results of Faunal Analysis

The preceding discussion of methodology described both standardized and project-specific procedures used in the current research to prepare and analyze a sample of faunal materials from Arenosa Shelter that are now contained in the research collections of TMM-VP. The analysis allowed verification of previous analyses, specifically regarding species identification of many of the previously recorded specimens. However, the more detailed examination and analysis conducted during the current research also enabled significant revisions to be made that enriched the knowledge of fauna present during Archaic occupation of the Lower Pecos cultural region. This enrichment expanded the foundation for understanding indigenous cultural behavior during the Lower Pecos Archaic.

SPECIES IDENTIFICATION

As previously indicated, the author determined at the outset of research that the archaeofaunal sample excavated from Arenosa Shelter was richly varied in composition, but dominated by significant amounts of rabbit and deer remains. The author assumed, using an extension of the reasoning by the site's excavators (cf. Dibble 1967), that these remains at least partially represented the residues of cultural behavior associated with fulfilling subsistence and technological needs. Detailed examination of approximately 4,900 individual specimens from 85 lots allowed the preliminary observations of previous NPS and NSF-funded collections management research to be verified and expanded. The current research results documented the presence of a wide range of the resident and transient fauna available in this region. Identification of individual specimens was made to the taxonomic level most appropriate, given the particular anatomical characteristics for each specimen. The following table presents a composite of taxa identified during the current research.

It should be noted that over 140 individual taxonomic assignments were made during analysis of the Arenosa Shelter sample, filling the full range of classifications between Class and sub-species levels. Taxonomic assignments included one sub-species, sixty-five species, thirty-three made to genus, twelve made to family, ten made to order, and twelve to class only. Identification was successfully made for many specimens to either genus or species. The Arenosa Shelter faunal sample was diverse in its makeup, especially in the site's better-preserved upper strata.

QUANTIFICATION AND CONTEXT IN ASSEMBLAGE

Data for specimens examined by the author were recorded as 2,380 records in a FileMaker Pro database during data collection. These data were exported to Microsoft Excel spreadsheets during analysis. Records originally separated in the FileMaker Pro database by provenience and taxonomic assignment were aggregated in several ways, including by taxa, provenience, regional cultural period, and cultural stage. Values were derived for NISP, MNI, and MNE. These data are presented in Table 5.2, organized by provenience unit.

The NISP, MNI, and MNE measures aggregated by regional cultural period are presented in Tables 5.3, 5.5, and 5.7. Percentages were calculated for each measure and as a composite value for the sample itself. The percentages aggregated by regional cultural period are presented in Tables 5.4, 5.6, and 5.8.

A composite figure of NISP, MNE, and MNI differentiated by regional cultural stage is presented in Table 5.9 and Figure 12.

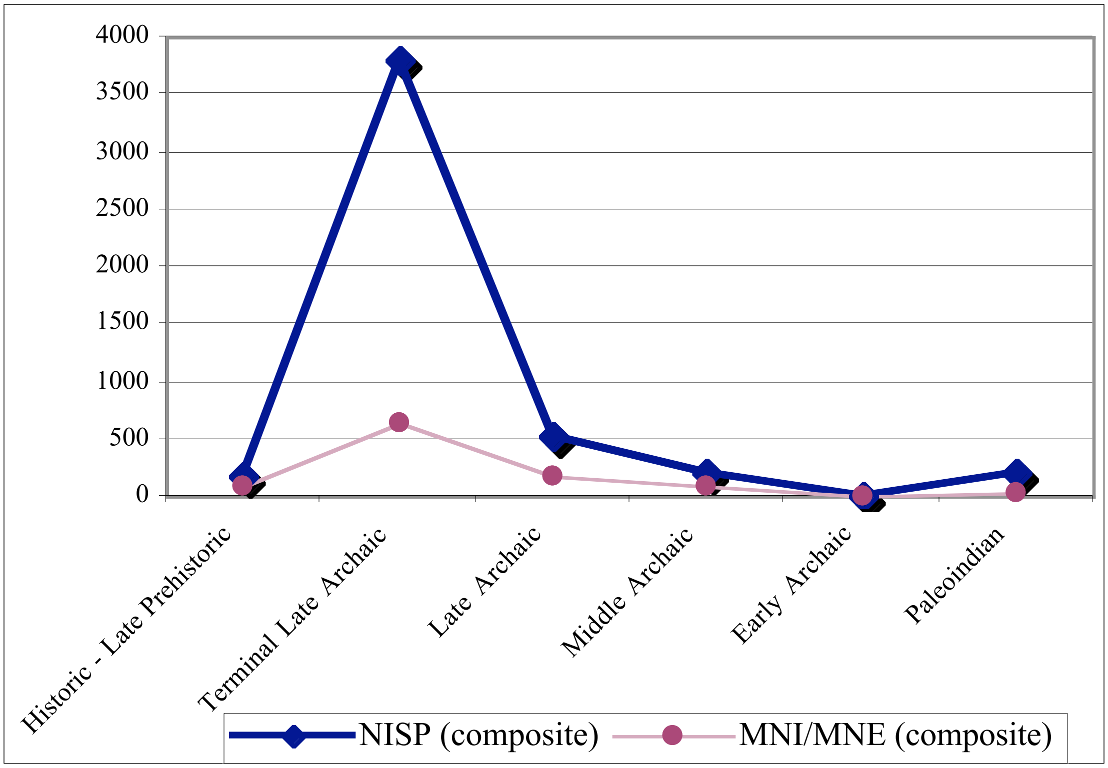

Figure 12: Composite NISP, MNE, and MNI Data Arranged by Cultural Stage

When the aggregations by cultural stage are examined, it is evident that two taxa are most frequent in the Arenosa Shelter collection sample, especially when the Late Archaic and later cultural stages are considered. This prevalence is evident for both NISP and the two measures that look more closely at minimum numbers of individual carcasses represented. Most fragments in the sample were identified as mammalian (NISP n = 3391; MNE/MNI n = 609), with significant numbers of fish fragments also present (NISP n = 1357; MNE/MNI n = 285). Bird remains were appreciably less numerous in the sample (NISP n = 90; MNE/MNI n = 61). Relatively few reptile fragments were identified (NISP n = 58; MNE/MNI n = 31), mostly turtle remains. Amphibians were virtually absent from the sample (NISP n = 5; MNE/MNI n = 3).

The total NISP count included a large number of fragments that could be differentiated only to vertebrate class. About 18 per cent of the total NISP tally consisted of mammal (n = 629) and fish (n = 254) fragments that lacked distinguishing characteristics allowing more specific taxonomic assignment. The tallies for MNI/MNE associated with mammal or fish fragments unidentifiable beyond vertebrate class were considerably less (mammalian n = 10, fish n = 21).

Mammalian lagomorph species are more frequent in this sample than any other taxa (NISP n = 1786; MNE/MNI n = 271). These members of the family Leporidae represent 36.4 per cent of the total sample and include two species of cottontail rabbit and jackrabbits. Cottontail remains make up the bulk of the leporid material, with the larger jackrabbits representing about 24 per cent of the total leporid NISP (n = 429) and almost 31 per cent of the total leporid MNE/MNI (n = 84). Most cottontail axial and appendicular skeletal remains could not be assigned to species due to the difficulties expressed by Hulbert (1984) for differentiating between smaller *Sylvilagus* species. Identifiable in the cottontail remains are a few individuals identifiable as the small desert cottontail (NISP n = 9; MNE/MNI n = 5) and slightly larger eastern cottontail (NISP n = 3; MNE/MNI n = 3).

Large mammals, defined here as those weighing above 40 kg, included representatives of the orders Artiodactyla and Perrisodactyla present regionally. Deer, sheep, bison, and pronghorn antelope are artiodactyls identified in the Arenosa Shelter sample. Horse species were also present in the oldest deposits. Large mammal fragments constituted 13.1 per cent of the sample NISP (n = 642) and 13.9 per cent of the sample MNE/MNI (n = 138).

Non-lagomorph medium-sized mammals, defined for this study as weighing between 1.0 kg and 40 kg, included the largest rodent (beaver) present in the sample and all mammalian carnivores. The broad category also included fragments that were identifiable as medium mammal in size and characteristics but lacking the distinctive characteristics allowing more specific taxonomic assignment. Medium mammal fragments constituted about 3.3 per cent of the sample NISP (n = 161), but 13.9 per cent of the sample MNE/MNI (n = 138).

Small mammals, defined here as those weighing less than 1.0 kg, included all rodents except the beaver. Fragments of small mammals made up about 3.5 per cent of the sample NISP (n = 173) and 9.3 per cent of the sample MNE/MNI (n = 92).

Although a diverse array of fish remains was identified and analyzed in the Arenosa Shelter sample, catfish (Order Siluriformes) and minnows or suckers (Order Cypriniformes) are most common. Overall, catfish represented 10.6 per cent of the total sample NISP (n = 519), while suckers comprised 6.6 per cent of the sample NISP (n = 323). In terms of the sample MNE/MNI, catfish were 15 per cent (n = 149) while minnows or suckers were 6.5 per cent (n = 64).

Body size of fish varied greatly between taxa as might be expected, such as between small sunfish or bass and very large catfish. It also varied widely within a specific taxon where different age classes were present. For analytical purposes, five size classes were recorded for fish taxa where appropriate, ranging from small to large. Small fish represented 0.94 per cent of the sample NISP (n = 46) and 2.42 per cent of the sample MNE/MNI (n = 24). Small to medium fish represented 5.5 per cent of the sample NISP (n =271) and 6.56 per cent of the sample MNE/MNI (n = 65). Medium fish represented 9.12 per cent of the sample NISP (n = 447) and 18.28 per cent of the sample MNE/MNI (n = 181). Medium to large fish represented 3.26 per cent of the sample NISP (n = 160) and 5.3 per cent of the sample MNE/MNI (n = 54). Large fish represented 1.49 per cent of the sample NISP (n = 73) and 4.65 per cent of the sample MNE/MNI (n = 46).

It should be noted that at least two taxa recorded from the Arenosa Shelter sample are currently not present in the vicinity of the lower Pecos watershed. These are the shovelnose sturgeon and a large, heavily-built gar that most closely resembles the alligator gar.

The avian archaeofauna was diverse, but sparse (NISP n = 90, MNI/MNE n = 61). It comprised only 1.84 per cent of the sample's total NISP and about 6.16 per cent of the sample's total MNE/MNI. Hawks, ducks and geese, and quail dominated the avian fauna. Both dabbling and diving ducks are represented in the sample, as are large and small geese. The white-winged dove, roadrunner, and an undetermined species of gull round out the avian fauna from the Arenosa Shelter sample and are represented by single specimens

Small to medium sized birds, such as quail, doves, and the smallest hawks, constituted 1.12 per cent of the sample's total NISP (n = 55) and 3.23 per cent of the total MNE/MNI (n = 32). All other avian taxa were considered to be large birds; they made up 0.5 per cent of the sample's total NISP (n = 25) and 2.36 per cent of the total MNE/MNI (n = 24). Although no direct osteological evidence of owls was present, their presence may be detected indirectly from the presence of skunks, a larger prey sometimes hunted by great horned owls in addition to their favored lagomorphs (Austing and Holt 1966:19; Johnsgard 2002:117). Great horned owls often hunt opportunistically at dawn and dusk from perches that provide a vantage point for short flights (Johnsgard 2002:117). Skunks are represented among the medium mammalian carnivores in the Arenosa Shelter fauna. Their remains exhibit ravaging typical of owls, including shearing of the braincase from the cranium (Austing and Holt 1966:31).

Both reptilian and amphibian remains were limited in diversity and quantity. The amphibian remains were extremely sparse and consisted only of frogs. Two species of ranid frogs were identified, but made up less than 1.0 per cent of the site's total NISP (n = 5) and MNE/MNE (n = 3). The reptilian remains were more common, with turtles being more numerous than snakes in the sample. Turtles represented about one per cent of the total NISP (n = 48) and 2.2 per cent of the total MNE/MNI (n = 22) for the sample, while snakes were 0.2 per cent of the sample's total NISP (n = 10) and 0.91 per cent of the total MNE/MNI (n = 9).

Changes through time for each of these groupings of taxa, including size classes of fish, are presented in Tables 5.10 - 5.11. A graphical representation of the NISP and MNE/MNI trends through time is presented in Figures 13 and 14.

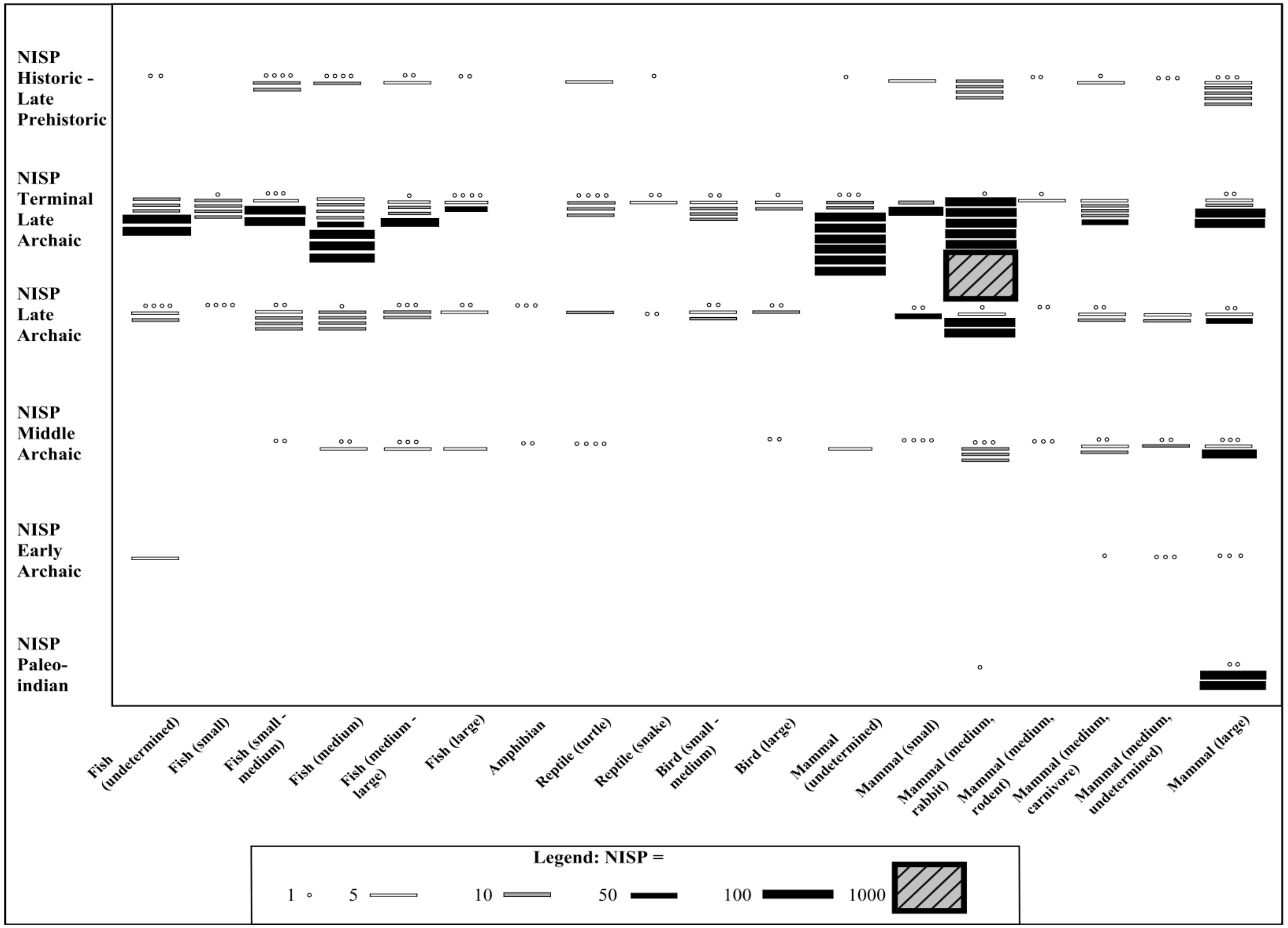

Figure 13: Vertebrate Class Body Size NISP Trend between Cultural Stages

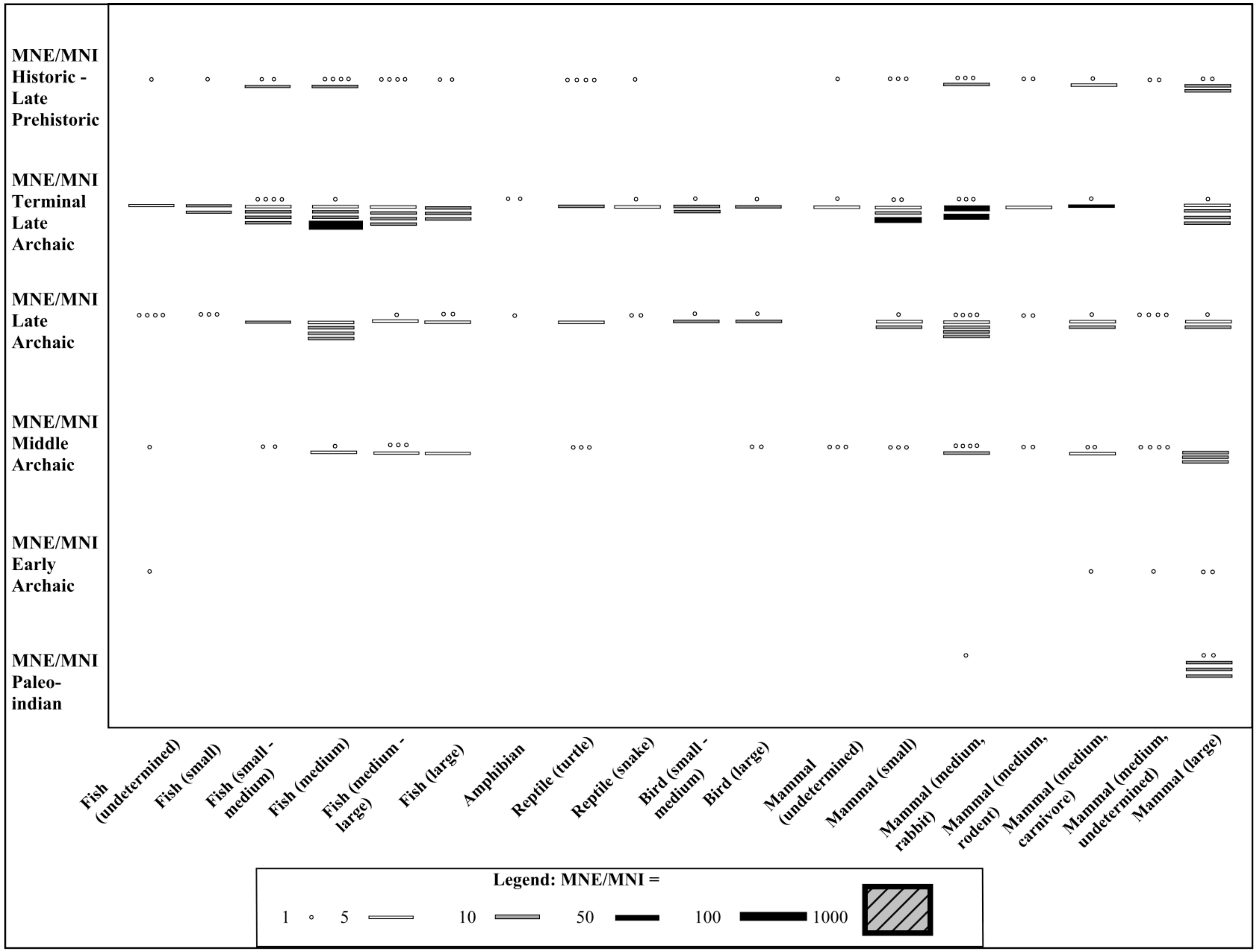

Figure 14: Vertebrate Class Body Size MNE/MNI Trend between Cultural Stages

As may be seen from the data and graphical representation in the foregoing figures and Tables 5.10 – 5.11, the Arenosa Shelter faunal sample exhibits differences between cultural stages represented in the site's stratigraphic record. The early cultural stages, Paleoindian and Early Archaic, are sparsely represented and correspond to 4.08 per cent of the sample total NISP and 3.94 per cent of the sample total MNE/MNI. It should be noted, however, that remains from the Paleoindian strata (NISP n = 187; MNE/MNI n = 33) are more numerous than the succeeding Early Archaic (NISP n = 13; MNE/MNI n = 6). The Middle Archaic strata have slightly more numerous remains than the Paleoindian stage (NISP n = 205; MNE/MNI n = 83). Within these early strata, large mammal remains in the *Bison antiquus* or *Equus* sp. size range effectively dominated the Paleoindian stage. Early Archaic remains are very rare in the Arenosa Shelter sample. Large mammal remains are prevalent in Middle Archaic strata and more frequent than remains of smaller mammals or other vertebrate classes. Fish were recovered from the Middle Archaic strata, but constituted a minority of the remains associated with this stage (NISP n = 21; MNE/MNI n = 15).

Strata from the Late Archaic, Terminal Late Archaic, Late Prehistoric, and Historic cultural stages exhibit a strong shift from the dominance by large mammal remains to a prevalence of remains from animals of medium body size. Importantly, fish were included in the category of animals with large body size for the first time beginning in Late Archaic strata. Large fish remains were identified as large gar, catfish, or cypriniform suckers. Late Archaic (NISP n = 59; MNE/MNI n = 30) frequencies for large fish were greater than for the succeeding Late Prehistoric – Historic (NISP n = 2 and MNE/MNI n = 2) and preceding Late

Archaic (NISP n = 7 and MNE/MNI n = 7). Large mammals included deer, pronghorn antelope, and sheep or domestic goat.

Even though animals of large body size were relatively more abundant than in earlier strata, those of medium body size widely surpassed them in frequency during the Late Archaic and succeeding cultural stages. Medium body size forms included large birds, many species of fish, rabbits, beaver, and mammalian carnivores. Rabbits were always the most common taxa. The Late Prehistoric – Historic composite rabbit NISP (n= 40) is considerably less than that of the Terminal Late Archaic (n = 1501) and Late Archaic (n = 211). The Middle Archaic strata yielded fewer rabbit remains (NISP n = 33), while the extreme disturbance in Early Archaic strata left none of the fragile leporids in place. A single rabbit fragment was found in Paleoindian context. The MNI/MNE measures point to the higher fragmentation of rabbit remains from Terminal Late Archaic strata (n = 203), compared to those from the Late Prehistoric – Historic (n = 13) and Late Archaic (n = 39) strata. Middle Archaic MNI/MNE frequencies (n= 14) also show less fragmentation of rabbit remains.

Mammalian carnivores are less common in Late Prehistoric – Historic strata (NISP n = 6; MNE/MNI n = 6) than those in the Terminal Late Archaic (NISP n = 85; MNE/MNI n = 51), Late Archaic (NISP n = 17; MNE/MNI n = 16), or Middle Archaic (NISP n = 17; MNE/MNI n = 7) strata. It should be noted that the raccoon was present in Middle Archaic, Terminal Late Archaic, and Late Prehistoric – Historic periods. Late Prehistoric – Historic occurrences of the raccoon (NISP n = 2; MNE/MNI n = 2) are approximately equivalent to those of the Middle Archaic (NISP n = 7; MNE/MNI n = 2). Those of the Terminal Late

Archaic were slightly more prevalent (NISP n = 8; MNE/MNI n = 7). Several robust individuals (NISP n = 2; MNE/MNI n = 2) were identified among raccoon specimens from Terminal Late Archaic strata that may be referred to the large Pleistocene-remnant subspecies (*Procyon lotor simus*). This subspecies was extirpated in the region within the last millennium. A smaller relative of the raccoon, the ringtail (*Bassariscus astutus*), was also present in equivalent frequencies during the latter two periods and also present during the Late Archaic. It was less frequent than the raccoon during the Late Prehistoric – Historic cultural stages (NISP n = 1; MNE/MNI n = 1) and more frequent during the Terminal Late Archaic (NISP n = 11; MNE/MNI n = 7). The ringtail was not numerous during the Late Archaic (NISP n = 4; MNE/MNI n = 3).

Domestic dog (*Canis familiaris*) remains were identified from Terminal Late Archaic strata (NISP n = 3; MNE/MNI n = 1), distinct from remains of the similarly sized coyote (*Canis latrans* NISP n = 5; MNE/MNI n = 3) in this period. The domestic dog remains consisted of fragmentary mandible with M_2, premaxillary, and isolated left lower canine smaller in size than coyote. Possible coyote (cf. *Canis latrans*) remains (NISP n = 4; MNE/MNI n = 2) were identified in Late Archaic strata. Numerous remains of a medium to large canid in the size range and build of domestic dog or coyote were identified in Terminal Late Archaic (NISP n = 23; MNE/MNI n = 6) and Middle Archaic (NISP n = 7; MNE/MNI n = 2) strata.

Smaller, fox-sized canids that could not be assigned to a more specific taxon were present in Late Archaic (NISP n = 1; MNE/MNI n = 1) and Terminal Late Archaic (NISP n = 3; MNE/MNI n = 3) contexts. Foxes were identified from strata of all cultural stages except Paleoindian. They included at least three species, the gray fox (*Urocyon cinereoargenteus*), two members of the fox genus *Vulpes*, the red fox (*Vulpes vulpes*) and the kit or swift fox (*Vulpes velox*). Remains of a large fox in the size range of both *Urocyon cinereoargenteus* and *Vulpes vulpes* was also present, but could not be assigned to a more specific taxon.

The frequency of fox remains is highest in the Terminal Late Archaic, with the gray fox being most common. Frequency for the gray fox peaks in the Terminal Late Archaic strata (NISP n = 11; MNE/MNI n = 9), with lesser numbers in the Late Prehistoric – Historic (NISP n = 3; MNE/MNI n = 3), Late Archaic (NISP n = 2; MNE/MNI n = 2), and Middle Archaic (NISP n = 1; MNE/MNI n = 1). The red fox is present in the Terminal Late Archaic (NISP n = 2; MNE/MNI n = 2). The desert-adapted kit or swift fox is present during the Terminal Late Archaic (NISP n = 2; MNE/MNI n = 1), Late Archaic (NISP n = 1; MNE/MNI n = 1), Middle Archaic (NISP n = 1; MNE/MNI n = 1), and Early Archaic (NISP n = 1; MNE/MNI n = 1). A fragmentary *Vulpes* sp. fragment that could be either red or kit fox was present in the Terminal Late Archaic (medial right tibia diaphysis, NISP n = 1; MNE/MNI n = 1). The large fox not assignable confidently to either genus was represented by a Terminal Late Archaic specimen (NISP n = 1; MNE/MNI n = 1).

A single fragment represented the bobcat. This small felid was identified from Late Archaic strata. The badger, largest of the mustelids, was identified from a single specimen excavated within Terminal Late Archaic strata.

Skunks, members of the family Mephitidae, were present in strata dating to the Terminal Late Archaic and Late Archaic. The small spotted skunks (*Spilogale* sp.) were identified, in addition to a fragment from an unidentified larger species of skunk in the genera *Mephitis* or *Conepatus*. Spotted skunk (*Spilogale* sp.) remains (NISP n = 5; MNE/MNI n = 5) were identified from Terminal Late Archaic strata and Late Archaic strata. The large skunk specimen also came from Late Archaic strata.

The only rodent within the medium body size category was the beaver. This important aquatic-adapted furbearer was found within Late Prehistoric – Historic, Terminal Late Archaic, Late Archaic, and Middle Archaic strata. Its frequency within the Terminal Late Archaic was significantly more (NISP n = 6; MNE/MNI n = 5) than the Late Prehistoric – Historic (NISP n = 2; MNE/MNI n = 2), Late Archaic (NISP n = 2; MNE/MNI n = 2), or Middle Archaic (NISP n = 3; MNE/MNI n = 2).

The large birds identified from the Arenosa Shelter sample were defined as being in the medium body size category. They included geese, ducks, broad-winged hawks (members of the genus *Buteo*), turkey, gull, roadrunner, and an unidentified species of large bird. Most large birds were found in Terminal Late Archaic strata (NISP n = 17; MNE/MNI n = 12), with fewer found in either Late Archaic (NISP n = 11; MNE/MNI n = 11) or Middle Archaic (NISP n = 2; MNE/MNI n = 2) strata. The turkey was found only in the Terminal Late Archaic strata (NISP n = 1; MNE/MNI n = 1). A gull of the family Laridae (NISP n = 1; MNE/MNI n = 1) was found in Late Archaic strata, as was the roadrunner (NISP n = 1; MNE/MNI n = 1). Broad-winged hawks (genus *Buteo*) and accipitrid hawks were found primarily in Late Archaic context (NISP n = 7; MNE/MNI n = 5), although they were also found in Terminal Late Archaic strata (NISP n = 4; MNE/MNI n = 4).

A single dabbling duck fragment (mallard, *Anas platyrhynchus*) was found in Terminal Late Archaic strata, while three other specimens separately identifiable as members of the family Anatidae were also found in these strata. One of those was mallard-sized, one was wood duck-sized, and one was only identifiable to family. Dabbling duck fragments were also identified from Late Archaic or Middle Archaic strata, with teal and gadwall both represented by single individuals. Diving ducks were also present in Late Archaic strata. Canvasback (NISP n = 2; MNE/MNI n = 1), redhead or scaup (NISP n = 1; MNE/MNI n = 1), and an unidentified diving duck (NISP n = 1; MNE/MNI n = 1) being represented. Geese genera *Chen* and *Branta* were only present in the Late Archaic, with both being represented by single specimens. Similarly, a large duck or small goose was represented by one specimen.

Small birds included small hawks, such as the Mississippi kite (*Ictinia mississippiensis*) and sparrow hawk (*Falco sparverius*), white-winged dove (*Zenaida asiatica*), and two species of quail—the Bobwhite (*Colinus virginianus*) and the scaled quail (*Callipepla squamata*). Small birds were isolated within strata of Late Archaic or Terminal Late Archaic ages. The NISP for small birds is dissimilar for the Terminal Late Archaic (n = 35) and Late Archaic (n = 17). The MNE/MNI frequency is more for Terminal Late Archaic (n = 21) than for Late Archaic (n = 12). Quail were the most common small bird during the Late Archaic and Terminal Late Archaic, but are more common in the Late Archaic

(NISP n = 30; MNE/MNI n = 19) than during the Terminal Late Archaic (NISP n = 14; MNE/MNI n = 8). The white-winged dove and small hawks were represented by very few specimens in each cultural stage.

Small mammals such as the gopher, common muskrat, wood rat, cotton rat, rock squirrel, gray squirrel, and two species of ground squirrels were present in significant numbers, but were never as common as rabbits during any of the latter cultural stages. The small mammal NISP for Late Prehistoric – Historic strata was very sparse (n = 5), while Terminal Late Archaic strata contained significantly higher NISP frequencies (n = 110 and n = 52). Middle Archaic strata had about the same NISP frequency for small mammals as did Late Prehistoric – Historic strata (n = 4). Review of the MNE/MNI measures also revealed differences between the Late Prehistoric – Historic (n = 3), Terminal Late Archaic (n = 67), and Late Archaic (n = 16), with Middle Archaic strata (n = 3) again being similar to Late Prehistoric – Historic strata.

The frequency of smaller fish was lower in the Late Prehistoric and Historic stages (NISP n = 1; MNE/MNI n = 149) than during the Terminal Late Archaic (NISP n = 41; MNE/MNI n = 20) and Late Archaic (NISP n = 4; MNE/MNI n = 3). Smaller fish were less frequent than fish of medium body size, the most frequent size class of fish reported in Tables 5.10 and 5.11. Medium large fish were uncommon in the Late Prehistoric – Historic (NISP n = 7; MNE/MNI n = 4), but considerably more common in the preceding Terminal Late Archaic (NISP n = 126; MNE/MNI n = 35), Late Archaic (NISP n = 23; MNE/MNI n = 6). The Middle Archaic frequency of medium large fish was closer to that of the Late Prehistoric (NISP n = 8; MNE/MNI n = 6).

Reptiles and amphibians were both only present during the Late Archaic and afterwards. Two species of ranid frogs were present in the Arenosa Shelter fauna, with the bullfrog (*Rana catesbiana)* found in Late Archaic (NISP n = 2; MNE/MNI n = 1) strata and the leopard frog (*Rana pipiens*) found in the Terminal Late Archaic (NISP n = 3; MNE/MNI n = 12).

Among the reptiles, at least four different snakes were present, two of them venomous. No snake remains were present in contexts earlier than the Late Archaic. The non-venomous colubrids were present during the Terminal Late Archaic. They included the bullsnake (*Pituophis* sp. left dentale, NISP n = 1; MNE/MNI n = 1) and a form that could not be differentiated between the racer (*Coluber constrictor*) and coachwhip (*Masticophis flagellum*) (right dentale and vertebra; NISP n = 2; MNE/MNI n = 1). The crotalids included the Western diamondback rattlesnake (*Crotalus atrox*) and the copperhead (*Agkistrodon contortrix*). Vertebrae from the copperhead were identified from Late Prehistoric – Historic (NISP n = 1; MNE/MNI n = 1) and Terminal Late Archaic strata (NISP n = 1; MNE/MNI n = 1). A large vertebra from the Western diamondback rattlesnake was found in Late Archaic deposits (NISP n = 1; MNE/MNI n = 1). A left mandible specimen identified to *Crotalus* sp. (NISP n = 1; MNE/MNI n = 1) was found in Terminal Late Archaic strata, while a vertebra specimen that could not be differentiated between *Crotalus* sp. and *Agkistrodon* sp. was identified from Terminal Late Archaic strata (NISP n = 1; MNE/MNI n = 1). Vertebrae specimens that could only be identified as crotalid were identified in Terminal Late Archaic (NISP n = 1; MNE/MNI n = 1) and Late Archaic (NISP n = 1; MNE/MNI n = 1) strata.

Turtles were the most common reptile and, like the snakes, were found in Middle3 Archaic and later strata. Turtles were considered to be medium-sized animals. Three individual turtle genera were identified, along with undifferentiated members of the family Testudinidae, and a fragment that could only be identified to the sub-class Chelonia. Among the more confidently identified turtles, spiny softshell turtles (*Trionyx spiniferus*) were the most common and were identified from Late Prehistoric – Historic (NISP n = 4; MNE/MNI n = 3), Terminal Late Archaic (NISP n = 28; MNE/MNI n = 8), Late Archaic (NISP n = 6; MNE/MNI n = 3), and Middle Archaic (NISP n = 4; MNE/MNI n = 3) strata. The snapping turtle (*Chelydra serpentina*) was identified in from Late Archaic deposits (NISP n = 1; MNE/MNI n = 1), while a slider (*Pseudemys* sp.) was present in Terminal Late Archaic deposits (NISP n = 2; MNE/MNI n = 1). The undifferentiated testudinid specimens were identified from Late Prehistoric – Historic (NISP n = 1; MNE/MNI n = 1) and Late Archaic (NISP n = 1; MNE/MNI n = 1) contexts. The specimen that could only be identified to sub-class Chelonia was found in Terminal Late Archaic deposits (NISP n = 1; MNE/MNI n = 1).

Age and Sex Identification

Age and sex determination was approached using several methods of investigation. Several methods were used to determine the relative age of individuals represented by specimens. The first, used with most mammals, combined taxon-specific tooth replacement and wear characteristics, taxon-specific long bone epiphyses fusion schedules, relative element size, and skeletal surface texture to assign a relative age to specimens. In some cases, relative age assignments were more specific and based on taxon-specific previous research that had produced narrow age-classes on the basis of observed tooth eruption and wear or bone epiphyses fusion schedules, such as those reported by Severinghaus (1949) for deer, etc.

A second method for relative age determination was used specifically with fish and relied on data that Carlander (1970, 1977) reported concerning the sexual maturation age and size of most fish. They become active reproductively between the third and fifth year of life, especially in warm waters. For most of the larger fish taxa identified for the Arenosa Shelter faunal sample, such as catfish, suckers, bass, and gar, this would occur within a length range of about 200 – 350 mm. Smaller taxa, such as sunfish, mature earlier and at a smaller size, 100 – 150 mm. A more specific method was used in a limited manner and relied on a count of the number of growth annuli observed on vertebral centra. This method is commonly used in zoology and fisheries studies as an adjunct to similar studies of annuli in fin spines. The method is time consuming under the best of circumstances. It is not considered accurate or reliable by fisheries researchers in determining the age of fish taken from warmer waters, such as those in the lower Pecos River and much of Texas. The basis of their concern is that the warmer climate in the region does not allow sufficient seasonal differences in water temperatures to cause growth to cease during cold weather (D. Hendrickson, 1998:personal communication; G. Powell, January, 2003:personal communication). Such lack of seasonal growth rate does not allow the bone density differences to develop that result in formation of strong annuli and often result in multiple weak annuli per year.

The detailed examination of the 4,900 specimens during this analysis resulted in 2,380 individual entries recorded in the FileMaker Pro database. Age observations were differentiated into four classes. Among the database entries, 117 were listed as juvenile, 165 as subadult, 2,079 as adult, and 15 as old individuals.

Total NISP for all juveniles is 131, with an MNE/MNI of 62. As could be expected from the preceding description of the fauna recovered from Arenosa Shelter, cottontail rabbits are the most numerous of the juvenile forms recovered (NISP n = 68; MNE/MNI n = 26). Jackrabbits are also very numerous (NISP n = 17; MNE/MNI n = 11). Small rodents were common as carnivores (NISP n = 16; MNE/MNI n = 9). Carnivores were almost as numerous (NISP n = 12; MNE/MNI n = 3), with the most common taxon being a coyote or large dog-sized *Canis* sp. (NISP n = 10; MNE/MNI n = 1). Deer were also numerous (NISP n = 9; MNE/MNI n = 7) with single mule deer and white-tailed deer individuals being identified as part of the composite deer total. Juvenile non-specific mammal fragments were present (NISP n = 2; MNE/MNI n = 2), as were juvenile generalized bird fragments (NISP n = 2; MNE/MNI n = 2). Single juvenile quail and softshell turtle individuals were also recognized in the sample.

Age of individual was recorded as subadult in 165 of the sample's records. Total NISP for all subadult individuals is 188, with an MNE/MNI of 79. As with the juveniles, rabbits are most common (NISP n = 128; MNE/MNI n = 46). Cottontails constituted the bulk of the subadult rabbit remains (NISP n = 109; MNE/MNI n = 39), with the larger jackrabbits contributing almost 15 per cent of the composite subadult rabbit remains (NISP n = 19; MNE/MNI n = 7). Other subadult medium-sized mammals were less common (NISP n = 9; MNE/MNI n = 9). Canids made up the bulk of these, with the gray fox (NISP n = 3; MNE/MNI n = 3) being more common than the larger coyote or domestic dog (NISP n = 1; MNE/MNI n = 1), fox-sized canid (NISP n = 1; MNE/MNI n = 1), or generalized canid (NISP n = 1; MNE/MNI n = 1). Single subadult specimens also represented raccoon and beaver.

Subadult large mammal remains were also relatively common (NISP n = 24; MNE/MNI n = 10), with deer (NISP n = 15; MNE/MNI n = 7) being the most frequent subadult large mammal. *Bison antiquus* (NISP n = 1; MNE/MNI n = 1) and a non-specific large mammal (NISP n = 6; MNE/MNI n = 1) made up the remainder of the fragments recognized as subadult large mammal in the earliest levels of the site. In the uppermost levels of the site, a subadult sheep or goat (NISP n = 2; MNE/MNI n = 1) was also recorded.

Small mammals were the least common (NISP n = 12; MNE/MNI n = 6) body size range subadults represented in the sample. The most frequent small mammal subadults were the rock squirrel (NISP n = 5; MNE/MNI n = 2) and woodrat (NISP n = 4; MNE/MNI n = 2), followed by muskrat (NISP n = 2; MNE/MNI n = 1) and cottonrat (NISP n = 1; MNE/MNI n = 1). Fragments of non-specific small mammal bone (NISP n = 3; MNE/MNI n = 3) recognized as subadult were also present.

Age of individual was recorded as old in 15 of the sample's records. Total NISP for all old individuals is 15, with an MNE/MNI of 9. Over half of the specimens identified as old individuals were raccoon (NISP n = 8; MNE/MNI n = 2). Other specimens identified as old individuals included single individuals of deer (NISP n =1), cottonrat (NISP n = 2), woodrat (NISP n =1), white-throated woodrat (NISP n = 2), beaver (NISP n =1), and rock squirrel (NISP n =1).

Fragments of adults made up the remainder of the sample. Total NISP for adults was 4,576, with an MNE/MNI of 840. As may be expected from previous discussion, mammal remains are very frequent and were cataloged in 1,434 of the records from the Arenosa Shelter faunal sample. Fragments identifiable only to adult Mammalia and Osteichthyes were common when only NISP was considered (629 and 254, respectively), although their frequency dropped dramatically when only MNE or MNI were considered (10 and 20, respectively).

Cottontail rabbits were the most abundant adult mammal remains identifiable to the most specific taxon (NISP n = 1128; MNE/MNI n = 112). Adult jackrabbits were also very common (NISP n = 393; MNE/MNI n = 66). Mature deer were common, with 261 individual specimens identified (NISP n). These specimens represent 49 individuals (MNE/MNI). Within the adult deer category, fragments of adult mule deer (NISP n = 16; MNE/MNI = 9) and adult white-tailed deer (NISP n = 14; MNE/MNI = 7) were identified to species. Other adult large mammals represented included domestic sheep or goat (NISP n = 14; MNE/MNI = 2 that includes a subadult), *Bison bison* (NISP n = 4; MNE/MNI = 2), *Bison antiquus* (NISP n = 90; MNE/MNI = 9), horse (NISP n = 6; MNE/MNI = 3), pronghorn antelope (NISP n = 6; MNE/MNI = 6), and a large Pleistocene-aged deer that was between the sizes of the mule deer and elk (NISP n = 1; MNE/MNI = 1).

Fragments of adult birds were significantly less common than mammals, with a total of 67 records resulting in an NISP n = 84 and an MNE/MNI n = 56. Adult hawks (NISP n = 17; MNE/MNI n = 12), ducks and geese (NISP n = 13; MNE/MNI n = 10), and quail (NISP n = 32; MNE/MNI n = 18) were the most common adult birds represented in the Arenosa Shelter faunal sample analysis. Non-specific fragments identifiable to avian class were also present (NISP n = 9; MNE/MNI n = 8). Also present in very low frequencies were remains of an adult gull, turkey, and roadrunner (for each, NISP n = 1; MNE/MNI n = 1).

All fragments of reptiles were of sufficient size and characteristics to be identified as adult (NISP n = 58; MNE/MNI n = 31). Likewise, the amphibian remains were from adult individuals (NISP n = 5; MNE/MNI n = 3).

Adult fish fragments identifiable beyond class were very common (NISP n = 1,103). Due to recovery methods that effectively precluded recovering fragments of the smallest size classes of fish remains, all fish fragments were considered to represent adults for the purposes of this study. In the limited number of cases where vertebral annuli were counted (NISP n = 15), annuli counts ranged upward from 5 to 25. Species represented included the black buffalo, river carpsucker, flathead catfish, and blue or channel catfish. Vertebra were identified to the most appropriate taxonomic level based on detailed comparison of distinctive morphology and surface textured with modern specimens from TMM-VPL. The qualitative relationship between size and observed number of growth annuli is presented in Table 5.12 and is based on observed specimens.

Differentiation between sexes confirmed in only a very limited number of cases (NISP n = 28) with very few taxa. Taxa included *Bison antiquus, Odocoileus* sp., and *Castor canadensis*. Distinctive skull fragments of a single female *Odocoileus* sp. were identified in Late Archaic strata. Based on size in comparison to a sexed known age reference specimen, a molar from an old male beaver was identified from Late Prehistoric – Historic strata. Adult male *Odocoileus* sp. deer remains (NISP n = 6; MNE/MNI n = 5) were identified from Late Prehistoric – Historic, Terminal Late Archaic, and Late Archaic contexts in the Arenosa Shelter faunal sample, based on identification of antler fragments, long bone fragments with heavy muscle scars, and overall size and robustness of fragments. Remains of male *Bison antiquus* (NISP n = 20; MNE/MNI n = 2) were recovered from Paleoindian-age contexts. Differentiation of sexual characteristics for this taxon was based on comparison with published comparisons of sexual dimorphism in *Bison antiquus* skull and horn core characteristics for the young bull that made up Feature 18 in stratum 40. Other *Bison antiquus* remains of appropriate appendicular elements were too fragmentary to reliably compare to published data that would allow the sex of the animal to be distinguished.

BUTCHERING PATTERNS

Evidence of cultural modification of animal remains was recorded in 444 of the 2,380 individual records from the Arenosa Shelter faunal sample. A total of 566 individual specimens (NISP n) were considered to be culturally modified, resulting in an MNE/MNI of 454. Skeletal materials from the skull, axial, and appendicular regions exhibited evidence of damage from butchering or heat, *sensu* Binford (1981b) and Shipman, *et al*. (1984b). Most fragments with heat damage are recognized as problematic and reflecting bone disposal rather than cooking. A differential patterning of heat damage, reflected in color differences, indicates direct evidence of roasting with flesh still attached that insulated portions of the bone from burning. Taxa modified in these fashions included fish, birds, turtles, and a wide range of mammals.

Cultural modifications were considerably more prevalent among remains of large and medium mammals than small mammals. Culturally modified large mammal remains included deer, bison, pronghorn antelope, and goat/sheep. Medium mammal remains exhibiting modifications included carnivores, rabbits, and beaver. Among the small mammals represented in the Arenosa Shelter faunal collection, only the remains of rock squirrels (NISP n = 3; MNE/MNI n = 3) were culturally modified with butchering damage. While these rock squirrel remains were found in the same unit and stratum, (N200/W170, Stratum 9), two were found in three separate lots of material from two separate excavation cuts (1 and 2).

Fragments identifiable only to Class Mammalia included an NISP n of 46; MNE/MNI n = 20. Two of these fragments were identified as small – medium mammal; both were burned and calcinated, coming from Late Archaic contexts. Remains of two separate medium to large mammals (NISP n = 2; MNE/MNI n = 2) were culturally modified by helical fracturing and/or burning. A limb bone fragment from Late Prehistoric/Historic context was burned, split longitudinally, ground to shape, and polished. It was recognizable as a probable tool fragment. A ventral mandible fragment from a subadult individual in Middle Archaic context was fractured transversely on its proximal end. Large mammal fragments (NISP n = 14; MNE/MNI = 4) from three separate contexts exhibit damage from burning or helical fracturing. The contexts represented include Late Prehistoric – Historic, Late Archaic, and Middle Archaic. The remainder of the fragments identifiable only to Mammalia exhibits damage primarily from burning, sometimes intense enough to produce calcination (NISP n = 28; MNE/MNI n = 12). One fragment was a possible limb bone roughly 1 cm in diameter that has deep cut marks resulting in a transverse groove and snap fracture.

Remains of medium sized mammalian carnivores (NISP n = 19; MNE/MNI n = 19) show cultural modification primarily through presence of butchery damage (fracturing or cutmarks), although several (NISP n = 5; MNE/MNI n = 5) show evidence of burning only or in combination with butchery damage. Those with butchery damage (NISP n = 14; MNE/MNI n = 14) include gray fox, kit fox, dog and/or coyote, raccoon, ringtail, and badger. Among the carnivore remains with butchery damage are bones of the head and extremities. Several skull fragments (NISP n = 3; MNE/MNI n = 3) from Late Prehistoric – Historic context exhibit longitudinal cutmarks between the tooth row and infraorbital foramen on bucchal aspect of the maxilla or shallow transverse cutmarks along the supraorbital arch and temporal line on the superior aspect of the frontal. These included remains of a gray fox, raccoon, and coyote. Five mandibular fragments (NISP n = 5; MNE/MNI n = 4) from Late Prehistoric – Historic context exhibited damage from butchery or burning and included gray fox, ringtail, and badger. This was primarily transverse cutmarks along the ventral margin of the element that resulted in separation of the anterior element under the middle of the tooth row in the vicinity of the first molar. One of the gray fox mandible specimens had cutmarks flanking the condylar fossa at the element's articulation.

Carnivore axial or appendicular remains from Late Prehistoric – Historic, Terminal and earlier Late Archaic, and Middle Archaic context exhibited cultural modifications that consisted of burning or butchery damage. The modified remains (NISP n = 10; MNE/MNI n = 10) were those of coyote or domestic dog, gray fox, desert fox, a subadult undetermined small canid, and an adult large fox-sized canid. Three of these specimens were damaged by heat (Middle Archaic desert fox, Late Prehistoric – Historic coyote or domestic dog, and juvenile Late Prehistoric – Historic coyote or domestic dog) and a third (Middle Archaic coyote or domestic dog) was modified only by helical fracturing of the element. Cutmarks on specimens are in positions and orientations to sever muscles at joints for dismemberment (e.g. distal epiphysis of humerus with transverse cutmarks adjacent to medial epicondyle), to deflesh elements (longitudinal "filleting" cuts on diaphysis of humerus), or to remove distal portions of limbs in process of skinning (transverse cuts on posterior aspect of distal femur diaphysis, transverse cutmarks on distal portion of tibia and fibula).

Culturally modified leporid remains (NISP n = 126; MNE/MNI n = 126) included fragments of 49 jackrabbits (NISP and MNE/MNI) and 77 cottontails (NISP MNE/MNI). Burning affected jackrabbit remains (NISP n = 9; MNE/MNI n = 6) to a limited extent, with the effects of burning ranging from minor discoloration of portions of elements to total calcination. In some cases, the burning evidence indicates a lack of heat discoloration on flesh-covered portions of elements, a pattern that may be interpreted as supporting secondary butchering following cooking. Three of these also have butchering damage that includes cutmarks.

A total of 33 jackrabbit specimens (NISP n) exhibit butchering damage and represent 22 individuals (MNE/MNI n) from Late Prehistoric – Historic to Late Archaic context. The butchering damage is primarily cutmarks in positions and orientations to sever muscles and connective tissues at joints for dismemberment (e.g. distal epiphysis of humerus with transverse cutmarks adjacent to medial epicondyle; transverse cutmarks on body of pelvis immediately anterior to acetabulum; oblique cutmarks on distal femur just proximal to medial supracondylar tuberosity; transverse cutmarks on cranial aspect of proximal tibia to sever tendons; transverse cutmarks on distal tibia immediately proximal to lateral maleolus and on caudal aspect immediately proximal to perineum muscle sulcus; and transverse cutmarks on distal caudal aspect of humerus immediately proximal to olecranon fossa to sever triceps brachii muscle; transverse cutmarks on the supraglenoid tubercle of the scapula to sever the infraspinatus and deltoid muscles). Cutmarks are also in positions and orientations to deflesh elements (longitudinal or diagonal “filleting” cuts on diaphysis of humerus; transverse or diagonal cutmarks on caudal aspect of tibia diaphysis proximal to fibula insertion), or to remove distal portions of limbs in process of skinning (transverse cutmarks on distal aspect of tibia; transverse cutmarks on ventral dorsal and ventral aspects of proximal metatarsal). Similar to carnivore remains, one jackrabbit specimen from an early to mid-Late Archaic context exhibited cutmarks on the diastema portion of the mandible.

Cottontail remains also show evidence similar to the jackrabbits. A total of 73 specimens (NISP n; MNE/MNI n = 75) were culturally modified in some fashion, with almost half (NISP n = 33; MNE/MNI n = 33) affected by burning. Butchering damage is little different than that documented for jackrabbits, with cutmarks in positions and orientations to sever muscles and connective tissues at joints for dismemberment, to deflesh elements, and to remove the skin. Mirroring the evidence for jackrabbits, evidence of skinning is provided by cutmarks on cottontail metatarsals, although no parallel to the skinning damage on jackrabbit mandible was found among the cottontail remains. However, cutmarks were documented on the dorsal margin of the pelvis and are interpreted as skinning damage. The metatarsal and pelvic skinning evidence is found in a Late Archaic context; faint cutmarks on the distal caudal-medial aspect of cottontail tibiae provided evidence of skinning from Late Prehistoric/Historic context. Contrary to the pattern for jackrabbits, there is no evidence on the Arenosa Shelter's sample cottontail scapulae or pelves for disarticulation of the shoulder or hip joints facilitated by severing muscles or connective tissues at the articulation itself. Disarticulation of these joints in cottontails may have been accomplished in different fashion, with severing of muscles on the proximal femur or humerus and occasional fracturing of the element diaphysis instead. As with jackrabbits, evidence for burning damage indicates a lack of heat discoloration ("smoking" or more intense darkening) on flesh-covered portions of elements. This pattern may be interpreted as supporting secondary butchering following skinning and cooking**.**

Culturally modified rodent remains were documented in Late Prehistoric – Historic and Late Archaic contexts, all modified by skinning or butchering damage. One specimen each of beaver and muskrat were recovered from Late Prehistoric – Historic context. The beaver specimen is a metatarsal fragment modified in the same fashion as lagomorph and carnivore specimens showing skinning damage. The muskrat specimen is a tibia fragment with mid-diaphysis caudal-medial cutmarks that may have severed connective tissues to allow disarticulation or allowed removal of the pelt. Three rock squirrel fragments from Late Archaic context, two pelvic and one tibia diaphysis. The tibia fragment has shallow cutmarks on its lateral aspect that allowed connective tissues to be severed. Cutmarks on the two pelvic fragments are posterior to the acetabulum and allowed disarticulation of the hip joint by severing the gluteus minimus muscle and connective tissues.

Culturally modified bird remains were rare and consisted of the lower limb bones of quail (NISP n = 2; MNE/MNI n = 2), diving duck (NISP n = 1; MNE/MNI n = 1), and hawk (NISP n = 3; MNE/MNI n = 1). One hawk (red-tailed or red-shouldered) tibiotarsus specimen from Late Prehistoric – Historic context was burned only, the diving duck specimen from Late Archaic context was slightly burned similar to the partially burned rabbit specimens and had dismemberment cutmarks on the distal caudal aspect. Two quail tibiotarsae, one each from Late Prehistoric – Historic and Late Archaic context, exhibited defleshing cutmarks on the cranial aspect. One Late Archaic Cooper's hawk-sized acciptrid femur specimen exhibited dismemberment cutmarks on its caudo-lateral surface. A second red-shouldered hawk distal tibiotarsus specimen, from Late Archaic context, exhibits distinct deep transverse fractures of the groove-and-snap variety.

Six turtle specimens (NISP n; MNE/MNI n = 4) were culturally modified. Four of these were burned carapace specimens. One was a testudinid specimen from an upper Late Archaic context. The others (NISP n = 3) of these were spiny softshell turtle specimens from the same lower Late Archaic context and were considered to be from two individuals (MNE/MNI n = 2). Two spiny softshell turtle femur fragments from upper Late Archaic or lower Terminal Late Archaic context had transverse dismemberment cutmarks.

Culturally modified fish remains were common (NISP n = 161; MNE/MNI n = 108). Of these, 69 (NISP n; MNE/MNI n = 46) had signs of heat alteration. Within this group, 10 specimens (NISP n; MNE/MNI n = 8) also had butchering damage. The remainder (NISP n = 91; MNE/MNI n = 60) was modified by cutmarks associated with butchering or tool manufacture, polish, grinding, possible drilling, or possible human tooth marks. Elements modified in this fashion consist of vertebral centra and pectoral or dorsal spines. Vertebral centra of a variety of fish taxa were represented in the non-burned, culturally-modified sample, including catfish, gar, buffalo and carpsucker, white bass, and freshwater drum. All of these specimens came from Late Prehistoric – Historic or Late Archaic context and show a similar pattern of butchering damage.

Specific modification of vertebrae consists of cutmarks on the dorsal, lateral, and/or ventral aspects of vertebral centra parallel to the long axis of the body. In some cases, these cutmarks extend onto haemal or neural spines, neural arch, or transverse processes from the centra themselves. A total of 67 vertebral centra or haemal and neural arch fragments (NISP n) were modified in such a manner, representing 41 individuals (MNE/MNI n = 41). An additional specimen exhibited tooth marks on its margins, possibly related to human mastication rather than carnivore ravaging (Jones 1986; Wheeler and Jones 1989).

Spines of catfish and freshwater drum are also modified, most typically by transverse cutmarks. Only a few drum spines (NISP n = 4; MNE/MNI n = 3) were modified in this manner, all dorsal spines with cutmarks on the posterior aspect. One of these was also polished on its anterior aspect.

In the case of catfish spines, 23 specimens (NISP n; MNE/MNI n = 22) exhibited transverse or oblique cutmarks on the shaft or near the articulation at its base, or some other modification of the shaft or articulation. Three blue catfish pectoral spine specimen from Late Prehistoric – Historic context were broken near the base of the shaft of the spine and beveled in an arc from anterior to posterior. The break in one case was a groove and snap fracture, with the articulation on this specimen exhibiting possible drilling. Almost half of the catfish spines (NISP n = 11; MNE/MNI n = 11) had cutmarks at the base of the spine or on the articulation itself (ventral or anterior processes) that would have severed muscles at the articulation. Two of these specimens had a slight to significant polish evident on the shaft or its distal end. The remainder had transverse or oblique cutmarks on the shaft.

The largest group of culturally modified faunal remains from the Arenosa Shelter collection is from artiodactyl large mammals. A total of 169 specimens (NISP n) represent 146 individuals (MNE/MNI n). Of these specimens, almost a third (NISP n = 50; MNE/MNI n = 42) exhibit signs of heat modification of differing intensity. A few of these burned specimens (NISP n = 4; MNE/MNI n = 4) were exposed to intense heat and were calcined. Most were less intensely burned over part or their entire surface. Five specimens (NISP n; MNE/MNI n = 3) were “smoked” and had minimal heat discoloration. Burned artiodactyl remains were recovered from Late Prehistoric – Historic to early to mid-Late Archaic contexts.

Approximately 84 percent of the specimens (NISP n = 141; MNE/MNI n = 124) are modified through either fractures interpreted to be human-induced or through the cutmarks of butchering. Cutmarks are present on almost 48 percent of the culturally modified artiodactyl specimens (NISP n = 81), representing 67 individuals (MNE/MNI n). Remnants of human-induced fractures are present on a similar percentage of specimens (NISP n = 79; MNE/MNI n = 77). Such fractures represent fragmentation of the elements for marrow recovery during the latter stages of butchering or incorporation of bone into some stage of tool manufacture as a raw material.

Artiodactyl remains with butchering or heat damage were recovered from the lowest Paleoindian to Late Prehistoric – Historic contexts. Bison, deer, pronghorn, domestic sheep or goat, and an undifferentiated artiodactyl form are represented in culturally modified remains from the Arenosa Shelter faunal sample.

The evidence for cultural modification of bison in Paleoindian context is vague because much of the bone is in deteriorated condition and has been carnivore-ravaged. None of the bone from Paleoindian context is burned. Two individuals (MNE/MNI n=2) are represented by these 20 *Bison antiquus* specimens (NISP n=20) from Stratum 42 in the deepest excavated portion of Arenosa Shelter. One bison phalange is marked by two possible cutmarks. The other fragments represent a single bison radius that was marked by a transverse cut mark across the insertion for the brachialis muscle, distal to the radial tuberosity. The *Bison antiquus* remains from Stratum 40 also have only vague evidence for cultural modification and are discussed more fully in Chapter 7.

Due to extreme disturbance of the Early Archaic deposits in the site, very little evidence is available for procurement and use of artiodactyls. A single burned fragment of deer metatarsal was recovered from Early Archaic context in Stratum 32.

Evidence of butchered deer, mule deer, pronghorn, and an undifferentiated artiodactyl was present in Middle Archaic context within strata 12 – 30 (NISP n = 68 and MNE/MNI n = 47). Elements marked by dismemberment or defleshing cutmarks included 31 specimens (NISP n) representing 15 individuals (MNE/MNI). Dismemberment evidence included scapula, metapodial, and tibia fragments marked by transverse cutmarks proximally or by cutmarks along their margins. Defleshing cutmarks were found on deer scapula fragments as transverse cutmarks and scrape marks parallel to the long axis of the element.

Fragmentation for marrow removal was found on 19 specimens (NISP n), representing 18 individuals (MNE/MNI). Fracturing, grooving, and other modifications for tool manufacture were also found on several fragments.

Contexts with Late Archaic materials in strata 10 – 11 yielded evidence for cultural modification of deer. Fragments of burned deer remains from these contexts include 8 specimens (NISP n), representing 8 individuals (MNE/MNI n). Evidence of butchering was present on 7 specimens (NISP n) marked by skinning, dismemberment, or defleshing cutmarks representing 7 individuals (MNE/MNI). Fragmentation for marrow removal was found on 3 specimens (NISP n), representing 3 individuals (MNE/MNI). Longitudinal grooving for tool manufacture was also found on 2 fragments.

Deer dismemberment evidence from Late Archaic context included transverse cutmarks on scapula articulations, hind foot, skull, and proximal tibia fragments. Defleshing cutmarks were found as longitudinal scrapes and transverse cutmarks on scapula; stylohyoid, and proximal radius fragments. Fragmentation for marrow removal, bone grease production, or modification for tool manufacture was found on 7 specimens (NISP n) from Late Archaic contexts in strata 10 - 11, representing 7 individuals (MNE/MNI). Fragmentation for retrieval of fats residing in skeletal elements was found on 5 specimens (NISP n; MNE/MNI n = 5). Evidence consisting of helical or spiral fractures on element diaphyses or internal negative flake scars on element diaphysis fragments indicates marrow removal rather than preparation for bone grease production. Evidence for bone modification leading to potential tool manufacture or use was detected on 2 specimens (NISP n; MNE/MNI n = 2) and consisted of longitudinal splitting of metapodial elements, grinding of resulting fracture edges, and heavy polish of element and edge surfaces.

The Terminal Late Archaic context from Arenosa Shelter produced evidence for culturally modified artiodactyl remains in Strata 3 - 9 that included 99 specimens (NISP n) of deer, mule deer, pronghorn, and an undifferentiated artiodactyl. These were the remnants of 16 individuals (MNE/MNI n). Fragments of burned artiodactyl remains from this context included 29 specimens (NISP n) of deer or mule deer, representing 10 individuals (MNE/MNI n). Six of these specimens have irregular heat damage indicated roasting with attached flesh. Evidence of butchering was present on 47 specimens (NISP n) marked by skinning, dismemberment, or defleshing cutmarks representing 16 individuals (MNE/MNI). Fragmentation for marrow removal or bone grease production was present on long bone and scapular fragments of deer, mule deer, pronghorn, and undesignated artiodactyls, (NISP n = 33; MNE/MNI n = 14). Bone modification leading to tool manufacture or use was detected on 5 tool fragment or manufacturing debris specimens (NISP n; MNE/MNI n = 5). The evidence for tool manufacturing modification consisted of longitudinal splitting of metapodial elements, scraping or grinding of resulting fracture edges and surfaces, and heavy polish of element and edge surfaces.

Arenosa Shelter's Late Prehistoric – Historic context from above Stratum 3 yielded culturally modified artiodactyl remains from white-tailed deer, unidentified deer, pronghorn, domestic sheep or goat, and unidentified artiodactyls (NISP n = 12; MNE/MNI n = 4). Fragments of burned artiodactyl remains from these contexts include one specimen each of deer and domestic sheep or goat (NISP n = 2; MNE/MNI n = 2), although the burning evidence is not conclusively related to cooking. Evidence of butchering from Late Prehistoric – Historic context was present on 3 artiodactyl specimens (NISP n), representing an MNE/MNI n = 3. These included elements of deer, pronghorn, and unidentified artiodactyls marked by defleshing cutmarks.

Fragmentation for marrow removal, bone grease production, or bone modification for potential tool manufacture was found on 9 specimens (NISP n) from Late Prehistoric – Historic context, representing 4 individuals (MNE/MNI) that included white-tailed deer, unidentified deer, pronghorn, and unidentified artiodactyl. Fragmentation for retrieval of fats residing in skeletal elements was found on 8 specimens (NISP n; MNE/MNI n = 4). Evidence consisted of helical or spiral fractures on element diaphyses, internal negative flake scars on elements, and external blow-marks. Evidence for bone modification during tool manufacture or use was detected on one tool fragment (NISP n; MNE/MNI n = 1) and consisted of longitudinal splitting of metapodial elements and grinding of resulting fracture edges.

Chapter 6: Results of Bone Artifact Analysis

DESCRIPTION OF BONE ARTIFACT CATEGORIES

Analyses of bone and antler artifacts from Arenosa Shelter resulted in definition of two artifact classes broadly differentiated on the basis of form and function. The current analysis also revealed manufacturing and use wear characteristics from these artifact classes.

Ornaments and implements comprised the two defined artifact classes. The ornament class was primarily represented by segments of mammalian or avian long bone or antler fashioned into beads. Other long, narrow, cylindrical bone artifacts are problematical. Termed bone tubes, they may represent early stages in bone bead manufacture or, alternatively, may have a different function. Implements served a more utilitarian use and were typically undecorated. Most artifacts in this class used appendicular skeletal elements from large ruminant mammals as raw materials. Appendicular elements from fish also were used as raw material for a small percentage of implements.

Basis of Determination for Artifact Forms

The sample analyzed from Arenosa Shelter included a total of 547 artifacts. These represent almost 55 per cent of the bone artifacts cataloged in the NPS artifact collection from the site. The largest group of the artifacts were finished whole or fragmentary items in the implement class, manufacturing byproducts, or early stages from implement manufacture. Implements and their byproducts totaled approximately 56 per cent of the sample. Approximately 44 per cent of the sample was classified as ornaments or their manufacturing debris. Most (30 per cent) were finished whole or fragmentary items in this class. A further seven per cent consisted of early stages in the manufacturing process for ornaments or byproducts. Bone tubes constituted the remainder of the sample, or another almost seven per cent that were possibly also within the ornament class.

Manufacturing Characteristics

Bead manufacturing evidence in the sample included preforms, manufacturing failures, and debitage (*sensu* Emery 2001:74). Debitage and manufacturing failures were valuable because they contained epiphyses or articular ends of skeletal elements. The presence of distinctive anatomical features on the epiphyses made the debitage more identifiable than the isolated diaphyses that made up preforms, beads, or bead fragments. A schematic description of selected bead forms and their associated manufacturing debris is shown in Figure 15.

Conforming to standard terminology in the bone technology literature, proximal refers to the un-worked or hafted end when describing tapering bone tool forms (Lemoine 1997:22, 2001:3). This end will often be broader and have an articular surface present that may not be the anatomical proximal epiphysis of the skeletal element that the tool blank was detached from. Figure 16 graphically represents this relationship for artiodactyl metatarsals, a common source of implement raw material in the Lower Pecos.

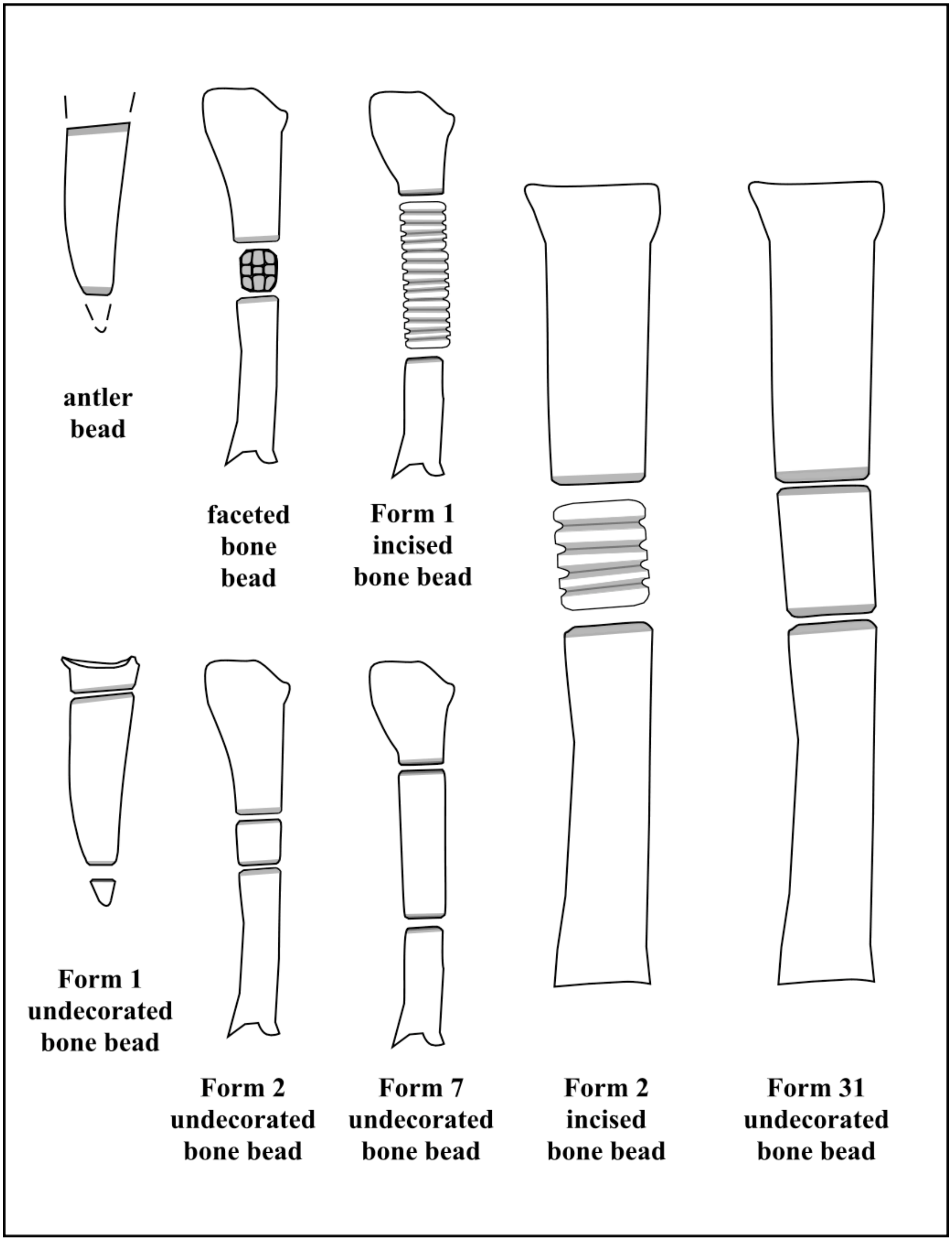

Figure 15: Schematic Drawing of Selected Bead Forms and Associated Manufacturing Debitage from Arenosa Shelter (Site 41VV99).

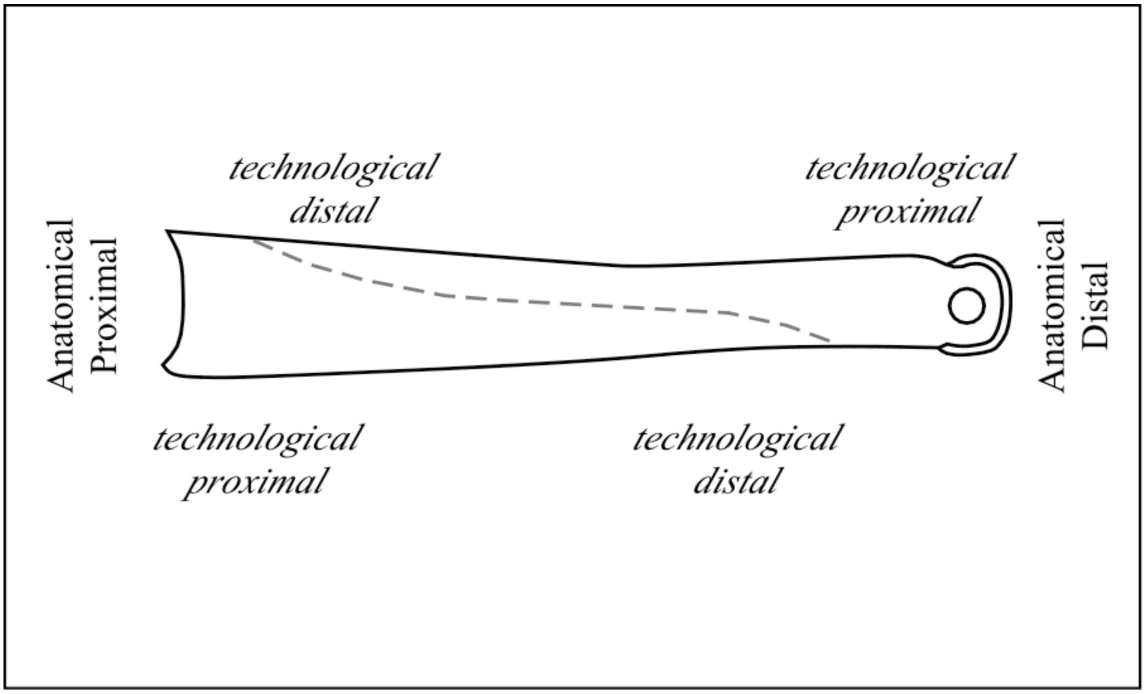

Figure 16: Lateral Schematic Comparison of Biological and Technological Anatomy of Artiodactyl Metatarsal-Based Implements.

In addition to finished tools, manufacturing evidence for bone implements in Arenosa Shelter's bone artifact collection included bone blanks, preforms, and byproducts that included manufacturing failures and debitage. Refitted or rejuvenated broken tools, informal tools, and expedient tools were also recognized during the analysis. Debitage, bone blanks, and manufacturing failures were valuable because they contained more identifiable anatomical features than the isolated diaphyses making up fragments of some tools and preforms. They also often contained clearer evidence of the techniques used to manufacture implements from bone and antler obtained in subsistence activities. Documentation of Lower Pecos implement manufacturing techniques used procedures experimentally verified by Griffits (1997), Lemoine (1997:23 – 30), and

Olsen (1980) for Native American manufacturing signatures elsewhere in North America. Characteristics of residual manufacturing criteria used in the present study are in Table 6.1.

Based on evidence from Arenosa Shelter, manufacturing techniques indicated a specific sequence for most bone implement production in the Lower Pecos cultural area. Techniques used to make formal tools included grooving or scoring with a lithic cutting tool and subsequent snapping apart of blank and debitage, scraping, grinding to shape, and polishing. Grooving included both longitudinal and circumferential directions on long bones, especially metapodials from deer and pronghorn antelope. Verified by microscopic examination of implements in the sample, scraping during manufacturing of formal tools may have had two roles: to remove the periosteum covering the bone surface and as an intermediate shaping method between grooving/snapping and grinding.

For informal tools, the manufacturing sequence was more variable. Dynamic fracturing of skeletal elements using a siliceous hammerstone produced expedient tools and smaller fragments that acted as blanks informal tool production. Several additional techniques shaped the actual working edge on informal tools. Unifacial or bifacial flaking produced a cutting edge, as did grinding. Scraping of the informal tools surfaces with a siliceous stone tool to produce minor additional shaping was documented. The role of scraping may have been only to remove the periosteal membrane.

Use Wear Characteristics

Following the manufacturing process, most ornaments and implements were used and worn through further surface modification from friction (Rabinowicz 1965:109-112). Friction alters surfaces through processes of attrition or addition and often results in a surface polish acquired through physical or chemical means (Barwell 1979; Dowson 1979; Griffits and Bonsall 2001; Lemoine 1997:7-8; Ruff and Ludema 1986). The study of wear patterns has proven very useful as bone technologists have adapted methodologies and research orientation from the lithic technology research to explain artifact function (Lemoine 1997:4-5). Extensive experimentation to verify use wear on bone tools has occurred in bone technology research within the past 15 years. The results of that research were adapted for the current study.

Documentation of use wear in the current study used procedures verified experimentally by Lemoine (1997:Table 4.14), Griffits (1997, 2001), and Olsen (1980, 1989) for use wear signatures on Native American mammal bone-derived tools elsewhere in North America. Although the structure of catfish spines is not the same as mammal bone, it is similar enough to warrant inclusion here with use wear on mammal bone tools. Characteristics of residual use wear criteria used in the present study are presented in Table 6.2. As defined by Lemoine (1997:21), the terms invasive and non-invasive in Table 6.2 refer to distribution of polish on bone artifacts. Invasive polishes cover all or most of the surface when wear is present, including sides and bottoms of striations. They are produced by a soft abrasive material conforming to the surface of an artifact. A non-invasive polish does not conform to the surface of an artifact, is produced by hard rigid materials, and primarily affects high points on an artifact. Lemoine (1997:21) recognizes that these two polish distributions form end points on a continuum.

Definition of Artifact Forms

Within the ornamentary artifact class, 40 forms of beads were defined. Several of these forms had decorations of incised grooves or ground facets. Bead forms are defined in Table 6.3 on the basis of manufacturing and use wear characteristics.

Within the implement class of artifacts, 29 basic forms were documented. These are defined in Table 6.4 on the basis of manufacturing and use wear characteristics.

QUANTIFICATION AND CONTEXT IN CULTURAL ASSEMBLAGE

The bone artifact sample from Arenosa Shelter contained complete and fragmentary ornaments, implements, manufacturing preforms and debris from a variety of contexts. Discussion about the stratigraphic context of Arenosa Shelter's technologically modified bone follows the conventions defined in Chapter 2 and used in earlier discussion of culturally modified faunal materials in Chapter 5. None of the bone artifacts occurred within the Early Archaic or Paleoindian contexts in the site. All came from Middle Archaic to Historic period cultural deposits in or above stratum 30 that were less affected by flooding.

Quantification, Composition, and Context of General Cultural Assemblage

All of the defined artifact forms were based on observations from the Arenosa Shelter bone artifact sample. About three per cent of the sample lacked vertical provenience. Less than five per cent of the artifacts in the sample were from Historic or Late Prehistoric contexts above stratum 3. The bulk of the sample, almost 60 percent, originated in Terminal Late Archaic contexts within strata 3 – 9. The remainder of the sample came from earlier Late Archaic (strata 10 – 11) or Middle Archaic contexts (strata 12 – 30). About eighteen (18.1) percent came from the site's lower Late Archaic strata and about fifteen (14.6) percent were deposited in Middle Archaic strata. A graphic representation of this frequency distribution is shown in Figure 17.

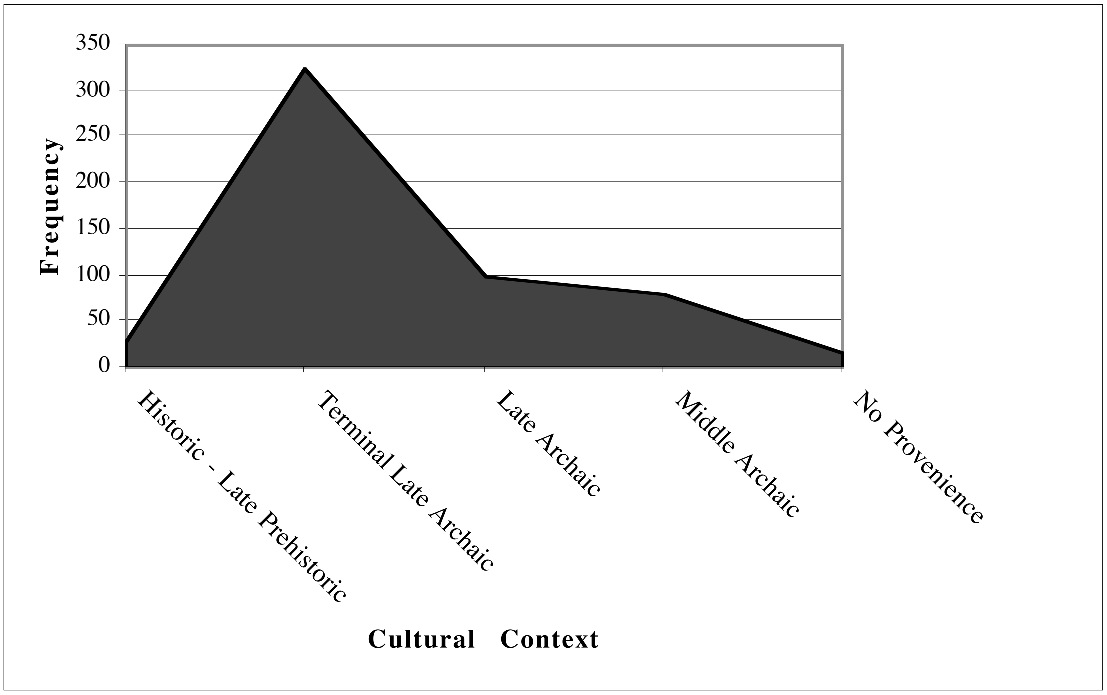

Figure 17: Frequency Comparison of Arenosa Shelter Bone Artifact Sample by Cultural Context

Mammalian appendicular skeletal material and antler supplied most raw materials for bone artifacts in the Arenosa Shelter collection. Artifacts made from these materials make up almost 85 percent of the sample. Frequency data for taxa providing raw materials observed in the Arenosa Shelter bone artifact sample are provided in Figure 18.

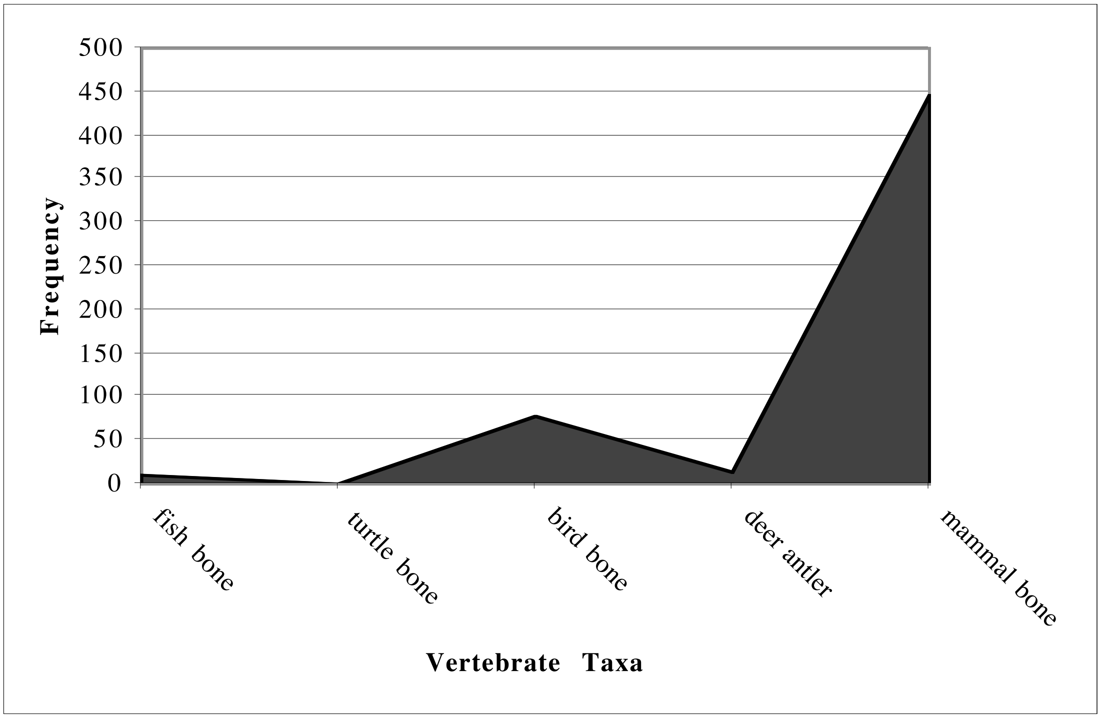

Figure 18: Frequency of Vertebrate Taxa Providing Raw Material Used in Arenosa Shelter Bone Artifact Sample.

Bird bone was used for a total of 78 artifacts in the sample. All of these were complete or fragmentary ornaments or their manufacturing byproducts. A single bead fragment of hawk bone was excavated in Historic or Late Prehistoric contexts. Terminal Late Archaic context in strata 3 – 9 provided 40 artifacts of bird bone, including three items of manufacturing debitage, 35 items complete or fragmentary beads or preforms, and five that were complete or fragmentary bone tubes or bead preforms. Earlier Late Archaic context within strata 10 – 11 contained 25 artifacts of bird bone, including 16 complete or fragmentary beads or preforms and eight complete or fragmentary bone tubes or preforms. A single item of bone bead manufacturing debitage of bird bone was found in this context. In Middle Archaic context, 12 bird bone artifacts found were complete or fragmentary bone beads or preforms. Most of the Middle Archaic bird bone artifacts were manufactured from the long bones of medium to large hawk species, although long bones from turkey, cormorant, and an unidentified bird taxon were also used in this fashion.

Fish bones or scales were used to manufacture ten artifacts, all of them in the implement class. A single ganoid scale from a large gar was apparently utilized as a butchering tool, with resulting areas of use wear polish having characteristics of meat contact. A large freshwater drum dorsal spine was also used in the processing of fresh hides. A second dorsal spine, this one from an unidentified fish taxon, was also used in the processing of silica-rich plant materials. All of the remaining implements made of fish bone originated from blue or channel catfish pectoral spines used as either perforators or spatulates in the processing of silica-rich plant materials or dry hides. With the exception of the gar implement from Historic or Late Prehistoric contexts above stratum 3, all remaining implements of fish bone were from Terminal Late Archaic context within strata 5 and 9.

A single softshell turtle plastron fragment from Middle Archaic context in stratum 25 was modified by incising and subsequent use. At medium to high magnification, it exhibits use wear consistent with wet hide.

Fifteen complete or fragmentary implements and ornaments made from deer antler were recorded in the Arenosa Shelter sample. They were found primarily in earlier Late Archaic context in strata 10 – 11 and Middle Archaic context in strata 12 – 25. One tool fragment made of antler tine originated in Terminal Late Archaic context in stratum 9. It has a distal bevel that exhibits wear consistent with use on wood. The four forms from the earlier Late Archaic context included flint-knapping tools for soft-hammer percussion and pressure flaking, a bead fashioned from a tine segment, and tine segment tools that appear to have been used in working hide or wood. Seven antler artifacts were found in this context at Arenosa Shelter and included tools fashioned from both beam and tine segments. In Middle Archaic context, seven artifacts of antler were also found, but were all manufactured from tine segments. On the basis of use wear and manufacturing characteristics, antler artifacts from Middle Archaic context apparently had a broader variety of functions than the Late Archaic tools and included pressure flaking tools, and hide and wood working tools. A single antler tube from Middle Archaic context was found that had been manufactured by chopping from an antler tine prior to subsequent surface scraping and grinding, but had no evidence of use wear.

All of the remaining 448 bone artifacts were manufactured of appendicular skeletal material from small to large mammals. The smallest taxa were cottontail rabbits, with 24 artifacts out of the mammalian group. Artiodactyls of pronghorn to mule deer size formed the upper limit on this range. They provided raw materials for 292 bone artifacts, the most numerous group in the sample. In between these two extremes, large leporids and small to medium-sized carnivores supplied skeletal material used in manufacture of 79 bone artifacts. Fifty-three of these were from jackrabbits and 59 were from carnivores in the fox to bobcat, coyote, or dog size range. Twenty-one artifacts made from the bone of an unidentified mammalian taxa made up the remainder of the sample. Figure 19 graphs the frequency distribution of taxa for bone artifacts manufactured from mammalian bone.

Among the 448 artifacts created from mammal bone, there were considerably more items representing the implement class and its manufacturing byproducts than those from the ornament class. A total of 287 artifacts represented the former, while 163 of the latter were found in the sample. The relative abundance of each class varied considerably through time. The variation in relative abundance may be a result of differential survival of the more robust members of the implement class in the rock shelter's alluvial sediments. Data comparing the frequency distribution between the ornament and implement classes through time is presented in Figure 20.

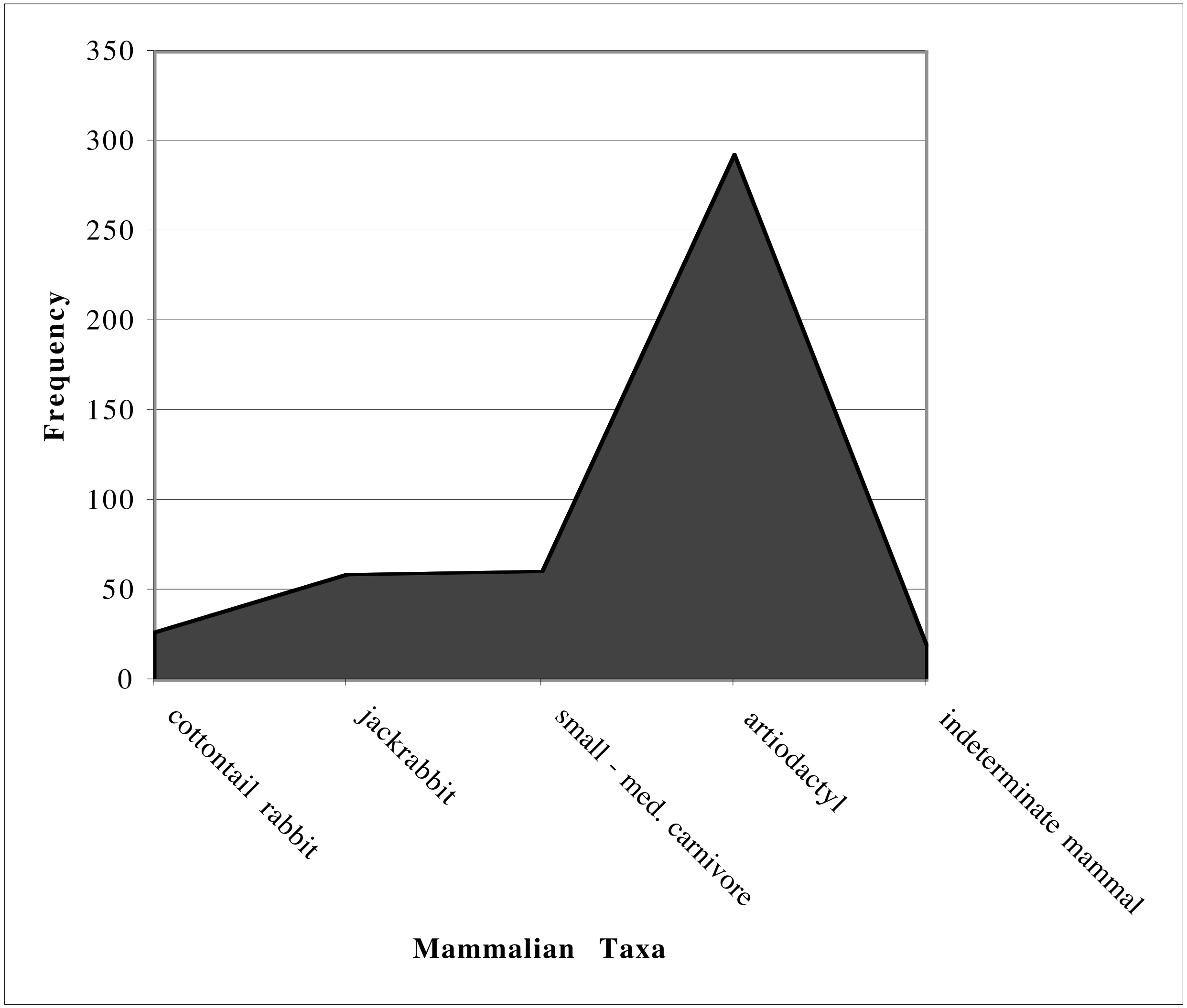

Figure 19: Frequency Distribution of Mammalian Taxa Represented by Bone Artifacts in the Arenosa Shelter Sample.

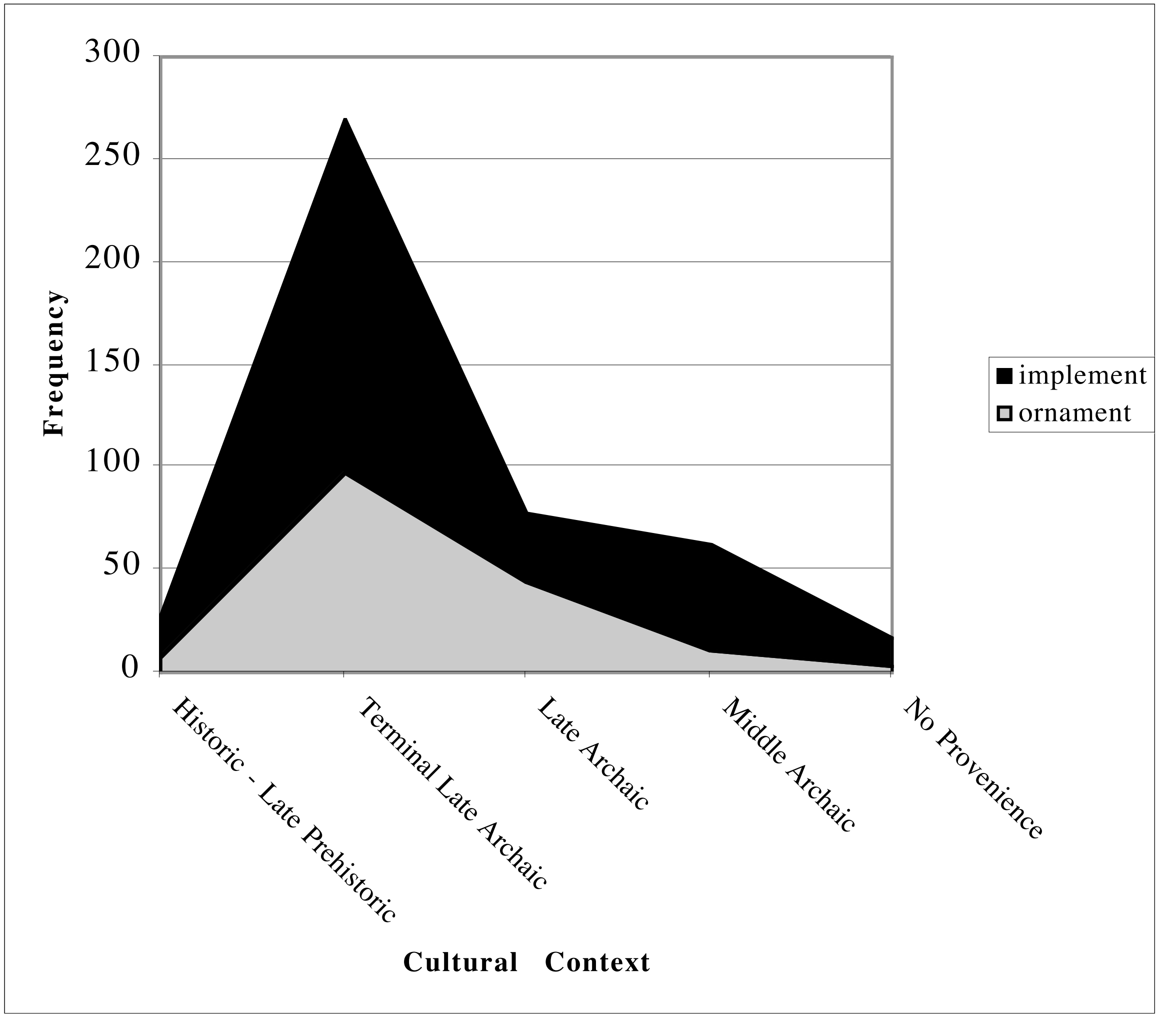

Figure 20: Diachronic Comparison of Frequency Distribution between Mammal Bone-Derived Artifacts in Arenosa Shelter Bone Artifact Sample.

Beads, bone tubes, and their manufacturing byproducts were the only artifacts identified within the ornament class. The author differentiated beads or bone tubes manufactured from four mammalian taxa with body size classes that ranged between cottontail rabbit and deer or pronghorns. Jackrabbits were also recognized as raw materials used for ornaments, as were small to medium-sized carnivores. Frequency data for mammal bone ornaments and implements are summarized diachronically in Tables 6.5 and 6.6.

A diachronic comparison of mammalian constituents of the two artifact classes is presented in Figure 21, differentiated by body size.

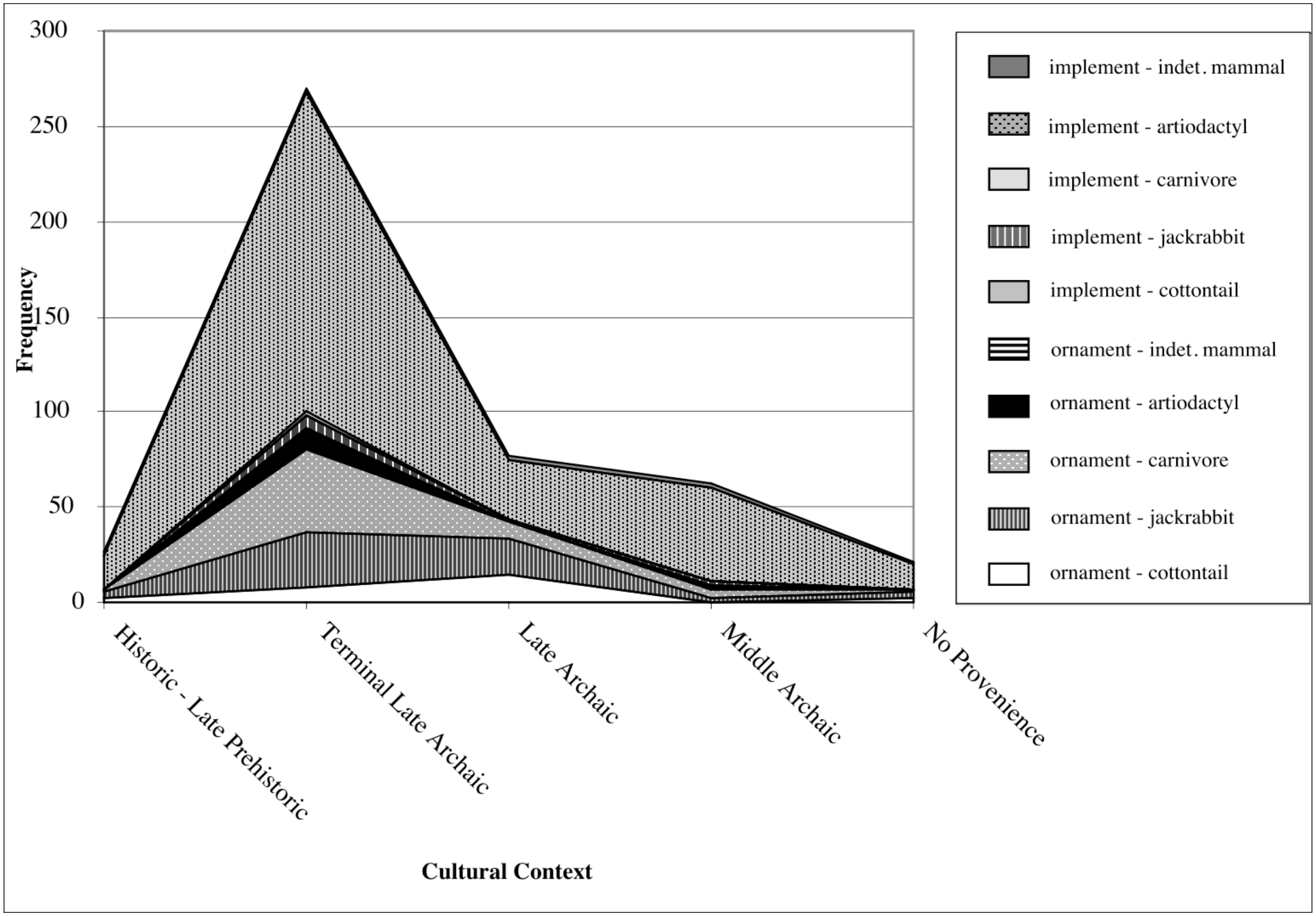

Figure 21: Diachronic Comparison Between Artifact Class Constituents by Taxa.

Cottontail rabbits provided raw material for 26 beads during or after the Late Archaic. They were most common in Late Archaic contexts in strata 10 – 11, with 14 items present. Eight cottontail beads were found in Terminal Late Archaic contexts in strata 3 – 9, with only two in more recent sediments above that level. Two cottontail-derived beads in the sample lacked provenience.

Among ornaments manufactured from medium-sized mammal skeletal materials, jackrabbit-derived beads were relatively common in Late Archaic context, with 20 items found in the sample from strata 10 – 11. The sample from Terminal Late Archaic context in strata 3 – 9 provided 29 beads manufactured from jackrabbit. Only four jackrabbit beads were present in Historic or Late Prehistoric context above stratum 3. Two jackrabbit beads were found in Middle Archaic context and two beads lacked provenience. Medium-sized mammalian carnivores utilized for ornamental artifacts were identified on the basis of size and remnant anatomical features and were primarily foxes, coyotes, or possibly domestic dog. The bobcat was also represented in this body size class. Carnivores of this sized class were common in Terminal Late Archaic context. The 43 complete or fragmentary beads or tubes, their preforms, and manufacturing byproducts made up almost 26 percent of the total mammal bone-derived ornament sample. They were virtually non-existent in Historic or Late Prehistoric context, with a single specimen present. Eight ornaments of carnivore bone were present in Late Archaic context within strata 10 – 11. Five beads manufactured from carnivore bone were present in Middle Archaic context below stratum 11. Three carnivore bone ornaments or their manufacturing byproducts lacked provenience.

Beads manufactured from appendicular skeletal material of artiodactyls were identified, but made up less than six percent of the bone ornaments in the sample. Most of them were present in Terminal Late Archaic context in strata 3 – 9 (11 items), although a single antler bead was present in Late Archaic context in strata 10 – 11, and two artiodactyl-derived ornaments or manufacturing byproducts were excavated from within Middle Archaic context below stratum 11. A final, indeterminate mammal designation was used for ornamental items that did not retain anatomical features that facilitated further taxonomic identification. Ornaments of this designation composed about six percent of the mammal bone ornament sample. They were most common in Terminal Late Archaic context (six items), with fewer found in Late Archaic and Middle Archaic contexts (two items each).

Only carnivores, indeterminate mammals, and artiodactyls were identified as providing raw materials for the wide variety of artifacts within the implement class, with artiodactyls providing raw materials for almost 96 percent of the 290 complete or fragmentary implements made of bone in the sample. Carnivore-based implements were present at less than one percent of the bone implements, with indeterminate mammals making up the remainder.

The artiodactyl-derived implements were clearly the most abundant artifact group in the site through much of the Archaic, based on the analyzed sample. An exception to this predominance occurs in the Late Archaic context. During this period, ornaments made from leporids of both size classes were slightly more abundant than artiodactyl implements and ornaments.

Quantification, Composition, and Context of Specific Artifact Forms and Manufacturing Byproducts in the Cultural Assemblage

The following discussion of quantification, composition, and context of specific artifact forms and their manufacturing byproducts in the cultural assemblage is organized by artifact class. It incorporates not only the taxonomic identification used in the preceding section, but also analysis of metrical, technological, and use wear data for the study specimens. The results of this stringent analysis are presented here in order to define the context within the underlying technological behavior for these artifact forms as completely as possible.

Ornament Forms and Manufacturing Byproducts

Forty bead forms were defined previously on the basis of observations of taxonomic, metrical, technological, and use wear data from specimens in the Arenosa Shelter bone artifact sample. Results presented earlier in this section noted that the greatest frequency of antler and bone beads, bead preforms, bone tubes, and bone tube preforms manufactured from mammalian and avian-derived constituents occurred in Arenosa Shelter's Terminal Late Archaic context. Slightly more than half of the ornaments in the analyzed sample originated within strata 3 – 9. Significant numbers of both constituents also occurred in earlier Late Archaic strata in the site, with about 29 per cent of the sample coming from this context. While not numerous, about ten percent (23 items) of the ornaments manufactured from avian and mammalian carnivore species were present in Middle Archaic contexts in Arenosa Shelter. Historic or Late Prehistoric contexts above stratum 3 provided only about three per cent (eight items) of the sample's ornaments. Slightly more than one per cent (three items) of the analyzed ornament class lacked provenience. Most ornament manufacturing debitage (87 per cent) was found in the site's Terminal Late Archaic context, although lesser amounts were also found in Late Archaic and Middle Archaic strata or lacked provenience. Frequency, measurement data, and cultural context for specific bead or bone tube forms and manufacturing byproducts is found in Table 6.7.

Deer antler and decorated bead forms were present in the sample in small numbers. A single tapered bead with an oval cross-section was made from a deer antler and found in Late Archaic context in strata 10 – 11. It was manufactured by removing the tip of a tine section and then the cancellous bone from the interior. Three forms of decorated beads were also present in contexts dating to the Late Archaic or later.

The sample contained two beads on which multiple facets had been produced by grinding. One of these was also from Late Archaic context in strata 10 – 11 and was fashioned from a jackrabbit radius. This bead had 10 relatively indistinct facets and exhibited a bright non-invasive polish from contact with silica-rich plant materials. The second faceted bead was from Terminal Late Archaic context in strata 3 – 9 and was manufactured from a hawk ulna. It exhibited several indistinct facets ground into its surface and had a medium invasive polish and slight rounding of high points typical of wear from contact with dry hide.

Two forms of beads with incised annular grooves were documented in the sample from contexts more recent than the Late Archaic. Form 1 beads were found in both Terminal Late Archaic and Historic – Late Prehistoric contexts. They were produced on narrow (<10 mm) long bone segments of hawk or rabbit that were typically incised with multiple annular grooves at intervals of 1 – 2 mm along their length. A single Form 1 incised bead fashioned from a jackrabbit tibia had only one annular groove incised at its midpoint. Form 2 incised beads were made from slightly wider (10 – 20 mm) segments of carnivore long bone that were similarly incised with at least one annular groove along their length and were found only in Terminal Late Archaic contexts. In all but one instance, cutting of the annular groove decoration was the only manufacturing step in addition to removing the blank from original long bone element. An exception to this generality was one Form 2 bead that was ground and polished to further shape it once the single annular groove had been incised. All incised beads exhibited use wear from contact with either dry hide or hide with hair. A graphic representation of the diachronic frequency of incised bead forms is shown in Figure 22.

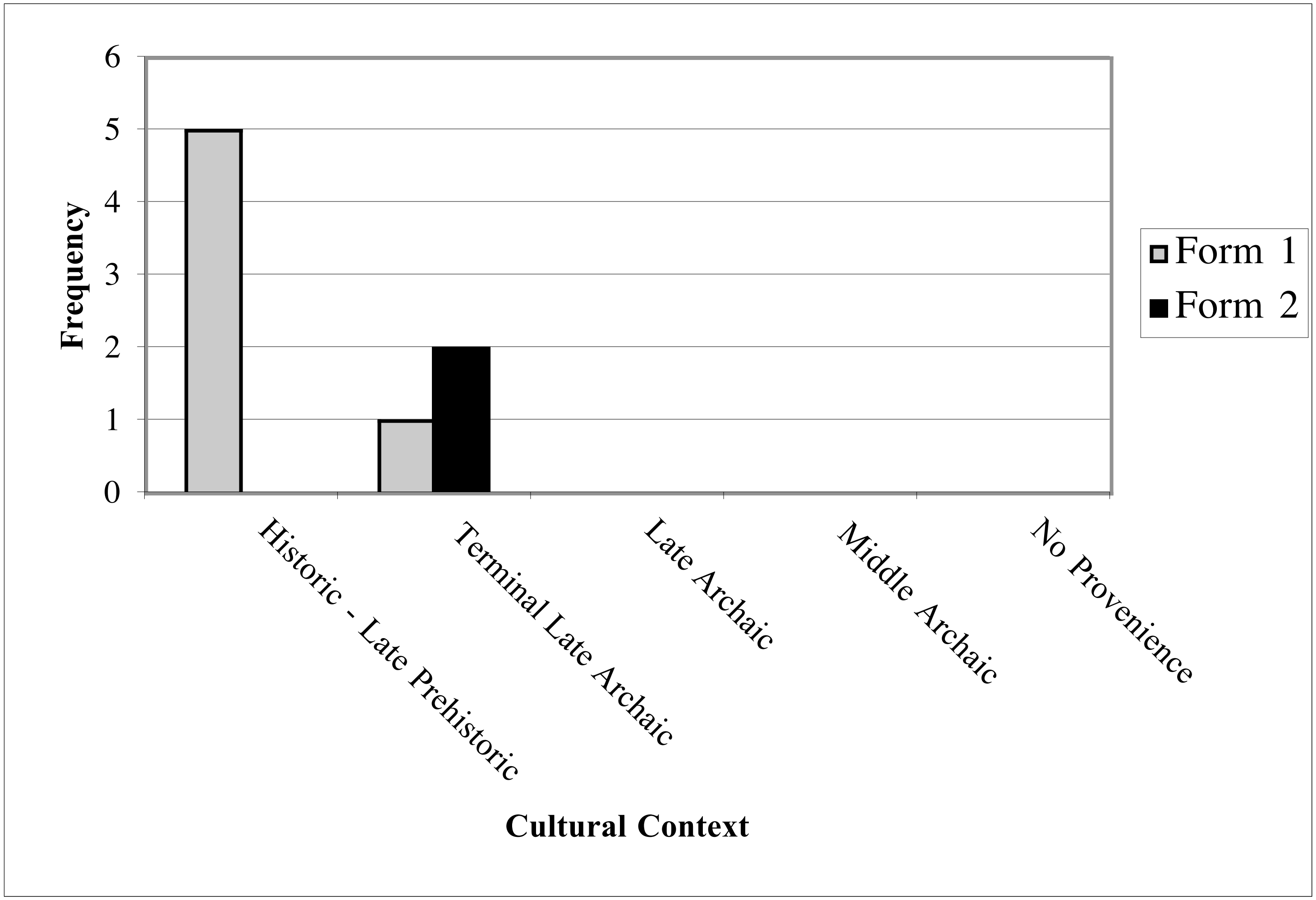

Figure 22: Diachronic Comparison of Frequency Distribution for Incised Bead Forms.

Undecorated tubular forms comprised the vast majority of all bone beads found in the sample. As previously presented in Table 6.3, 36 individual forms of undecorated bone bead were defined on the basis of size, source animal, and manufacturing process. The following narrative will discuss variations in these forms and resulting artifacts documented in the collection sample.

The first undecorated form (Form 1) was limited to two specimens from Terminal Late Archaic context in strata 3 – 9. These specimens were manufactured from deer or pronghorn phalange diaphyses and closely resemble the antler bead in being tapered longitudinally. They were longitudinally scraped during the manufacturing process and then ground or polished as a finishing method.

A group of 28 specimens in undecorated bone bead forms (2 – 6) may be considered together because they are similar in length (<20 mm) and share avian sources of raw material, primarily hawk taxa. The primary differences between the forms are based on width and degree of further surface alteration following detachment of the bead blank. Narrow beads (Forms 2 and 3) were less than 10 mm in width, while medium beads (Forms 4 – 6) were between 10 and 20 mm in width. Surface alteration consisted of minimal additional alteration (Forms 2 and 4), longitudinal scraping (Forms 3 and 5), or scraping with subsequent grinding and/or polishing (Form 4).

These forms were all found in Terminal Late Archaic context in strata 3 – 9 (20 specimens, all forms), although specimens were also found in Late Archaic context in strata 10 – 11 and in Middle Archaic context in strata below this level. Within the Terminal Late Archaic context, more (13) specimens were minimally modified than those subsequently undergoing scraping (five) or grinding/polishing (two) steps in manufacturing.

There is a difference between the Late Archaic and Middle Archaic representations of undecorated forms 2 - 6. Late Archaic specimens include only the two narrow forms (2 and 3). Middle Archaic specimens include the narrow, minimally modified form (Form 2) and a medium-width form that has been additionally modified through scraping and grinding or polishing. Wear on most of the specimens is attributable to contact with dry hide or hide with hair, although three specimens had wear consistent with contact by silica-rich plant materials. A graphic representation of the diachronic frequency of these undecorated bead forms is shown in Figure 23.

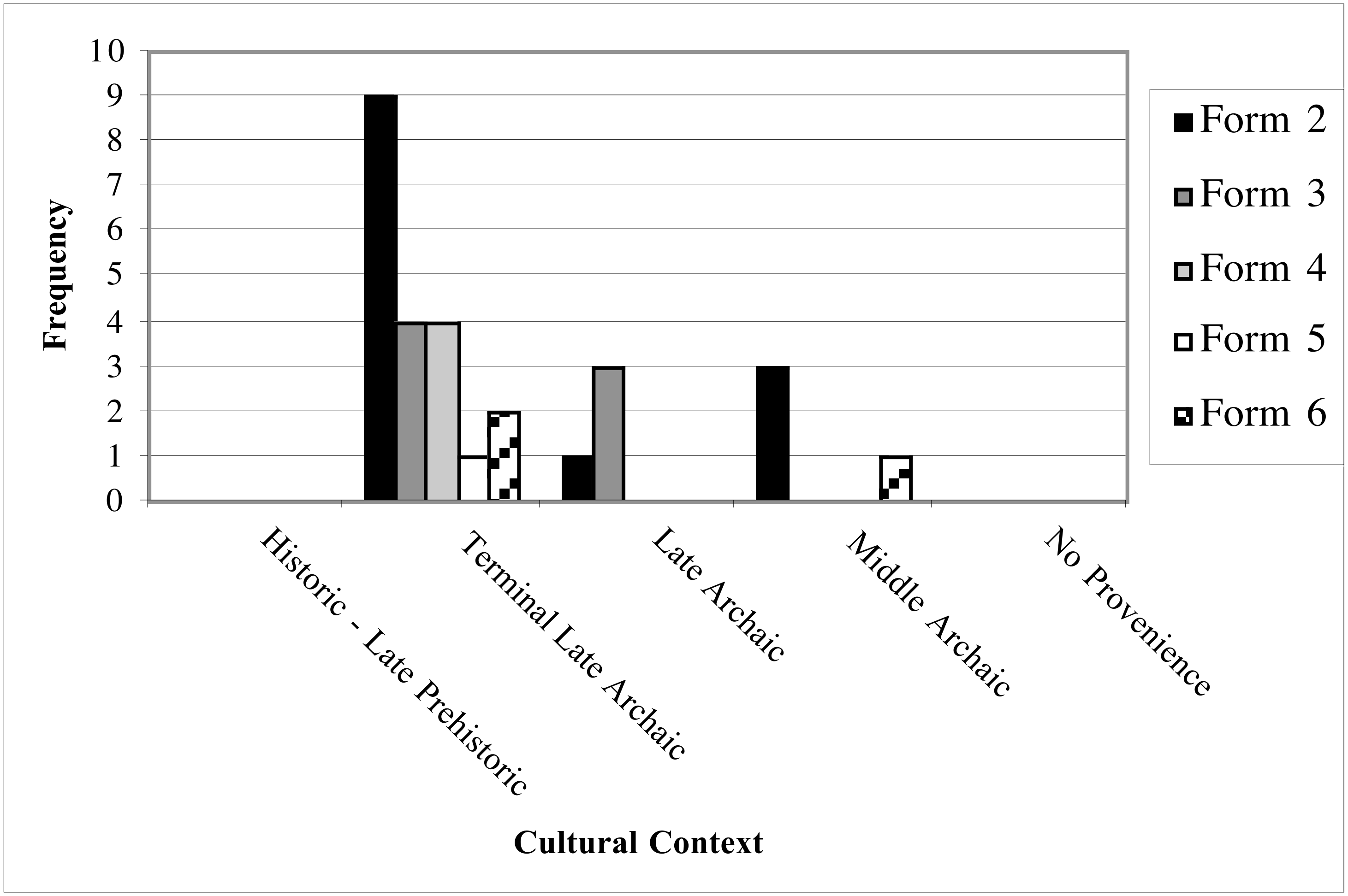

Figure 23: Diachronic Comparison of Frequency Distribution for Undecorated Bead Forms 2 – 6.

The next group of undecorated bone beads also contained 28 specimens and consisted of seven forms (7 – 13). As noted in Table 6.3, these forms were medium (20 – 30 mm) or long (>30 mm) in length and narrow (<10 mm) or medium (10 – 20 mm) in width. Similar to the previous discussion about undecorated Forms 2 – 6, beads in undecorated Forms 7 – 13 varied in degree of further surface alteration following detachment of the bead blank. In addition, undecorated Form 12 contained items fashioned from more robustly built bird taxa that produced thicker wall thickness on the resulting beads.

Recovery context for these seven forms was Middle Archaic to Terminal Late Archaic, with almost half (13 specimens) originating in the latest of these. Medium length – medium width forms were slightly more prevalent in Middle Archaic context while the narrower or longer forms were more prevalent in later context. Forms with minimal additional modification accounted for approximately 40 per cent of the beads in these forms, with thicker, larger, minimally modified beads in Form 12 being more common in the Middle Archaic context and notably absent from Terminal Archaic context. Narrow to medium width beads in Forms 7 and 10 were more common in Late Archaic or Terminal Late Archaic context. Approximately 29 per cent of the specimens within this group of forms were additionally scraped (Form 8). Slightly more of them were found in Terminal Archaic context than in earlier Late Archaic strata. About one third of the beads in this group of forms (9, 11, and 13) were additionally ground and/or polished during the manufacturing process. Again, slightly more of them were found in Terminal Archaic context than in earlier strata. Wear on most of the specimens is attributable to contact with dry hide or hide with hair, although six specimens had wear consistent with contact by silica-rich plant materials. A graphic representation of the diachronic frequency of these undecorated bead forms is shown in Figure 24.

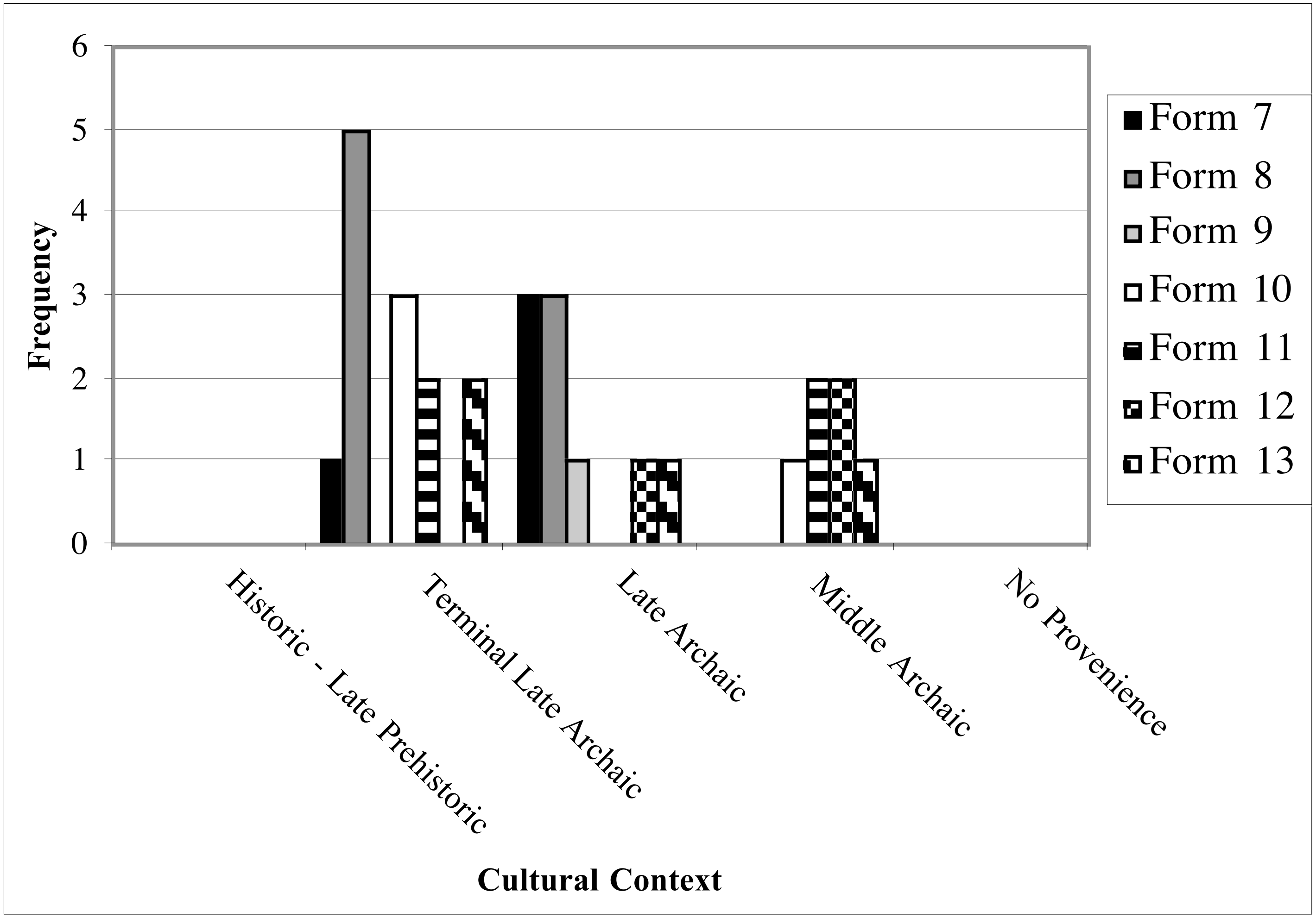

Figure 24: Diachronic Comparison of Frequency Distribution for Undecorated Bead Forms 7 – 13.

Undecorated bone beads fashioned from mammalian taxa comprise the remainder of the forms from the analyzed Arenosa Shelter sample and come from a wide range of source taxa ranging in size from cottontail rabbit to deer or pronghorn-sized artiodactyls. The initial group of undecorated bead forms is from the small end of this range and includes Forms 14 – 18. The group consists of short (<20 mm), narrow width (<10 mm) forms differentiated on the basis of wall thickness and degree of further surface alteration following detachment of the bead blank. Thin-walled forms include those with minimal surface alteration (Form 14), longitudinal scraping (Form 15), or scraping with subsequent grinding and/or polishing (Form 16). Other forms with evidence of scraping followed by subsequent grinding and/or polishing steps during manufacturing include a medium thick-walled (Form 17) and thick-walled (Form 18) variant. While this group of forms is represented in all contexts documented in this analysis, half of its 50 specimens come from Terminal Late Archaic context in strata 3 – 9. Forty per cent of its specimens also come from Late Archaic context in strata 10 – 11. The remainder is almost evenly split between Historic – Late Prehistoric and Middle Archaic contexts.

Minimally modified, thin-walled specimens make up Form 14 that contributes 13 of the total of 50 specimens in this group. A majority of these items (seven specimens) originated in Late Archaic strata. Although a large portion of the remainder (five specimens) come from Terminal Late Archaic context, the Middle Archaic is represented by a single specimen. All 13 of the specimens in this group are in the rabbit size range, with all but one identified as either cottontail or jackrabbit. A single specimen from an unidentified mammal taxon of similar size is also included. Slightly more than half of the specimens in this form exhibit wear consistent with dry hide contact. Five of the Form 14 specimens have wear more consistent with contact by silica-rich plant materials. A single specimen is burned, obscuring its wear signature.

Thin-walled specimens additionally modified by longitudinal scraping make up Form 15. This form contributed 24 of the total of 50 specimens in this group of short bead forms. Seventeen of these specimens were manufactured from jackrabbit long bones. Of the remainder, two specimens were manufactured from an unidentified small to medium-sized mammal taxon, four from cottontail rabbit, and one from a fox-sized canid.

Most of the Form 15 specimens (17) originated within Terminal Late Archaic context. They included two specimens from unidentified small to medium-sized mammals, two from cottontail, and 13 from jackrabbit. Six specimens came from Late Archaic strata and included the fox-sized canid, two from cottontail, and three from jackrabbit. Only one Form 15 jackrabbit-derived bead specimens was found in Middle Archaic context.

Use wear in the Form 15 specimens is primarily consistent with contact by silica-rich plants (10 specimens), although wear associated with contact from dry hide (nine specimens), sinew (one specimen), hide with hair (one specimen), and an unknown cause (one specimen) were also documented. A single specimen is burned, obscuring its wear signature.

Thin-walled specimens more extensively modified by grinding or polishing to final shape made up Form 16. This form includes 11 of the 50 short, narrow bead specimens. These were found in Late Archaic to Historic – Late Prehistoric context, primarily in Late Archaic strata. Sixty-four per cent of Form 16 specimens were found in Late Archaic context. The remainder of the specimens was evenly distributed between Terminal Late Archaic and Historic – Late Prehistoric contexts.

While the overall range of source animal taxa was used for raw materials as with Form 15, there was more variation within each context for Form 16. Within the Terminal

Late Archaic and Historic – Late Prehistoric contexts, single specimens of beads fashioned from jackrabbit and cottontail, respectively, were found. The seven Late Archaic beads included three fashioned from cottontail, two from jackrabbit, one from a small fox-sized canid, and one from an unidentified small to medium-sized mammal taxon.

The use wear for Form 16 specimens is consistent with that previously mentioned for Form 15. Wear caused by contact with silica-rich plants was exhibited on four Late Archaic specimens. Wear from dry hide was also documented for nine specimens, including all from Terminal Late Archaic and Historic – Late Prehistoric context.

Forms 17 and 18 are each represented by single specimens. The primary difference between these forms and the preceding Form 16 lies in the diaphysis thickness of the original skeletal element from the source animal and the resulting wall thickness for the manufactured bead. Form 17 was represented by a bead from Terminal Late Archaic context that was manufactured from an indeterminate long bone of a large fox-sized unidentified mammal taxon. Form 18 was represented by a bead from Middle Archaic context that was manufactured from a long bone of a medium-sized carnivore, probably a canid. Use wear for each was consistent with contact by hide. A graphic representation of the diachronic frequency of undecorated beads in Forms 14 - 18 is shown in Figure 25.

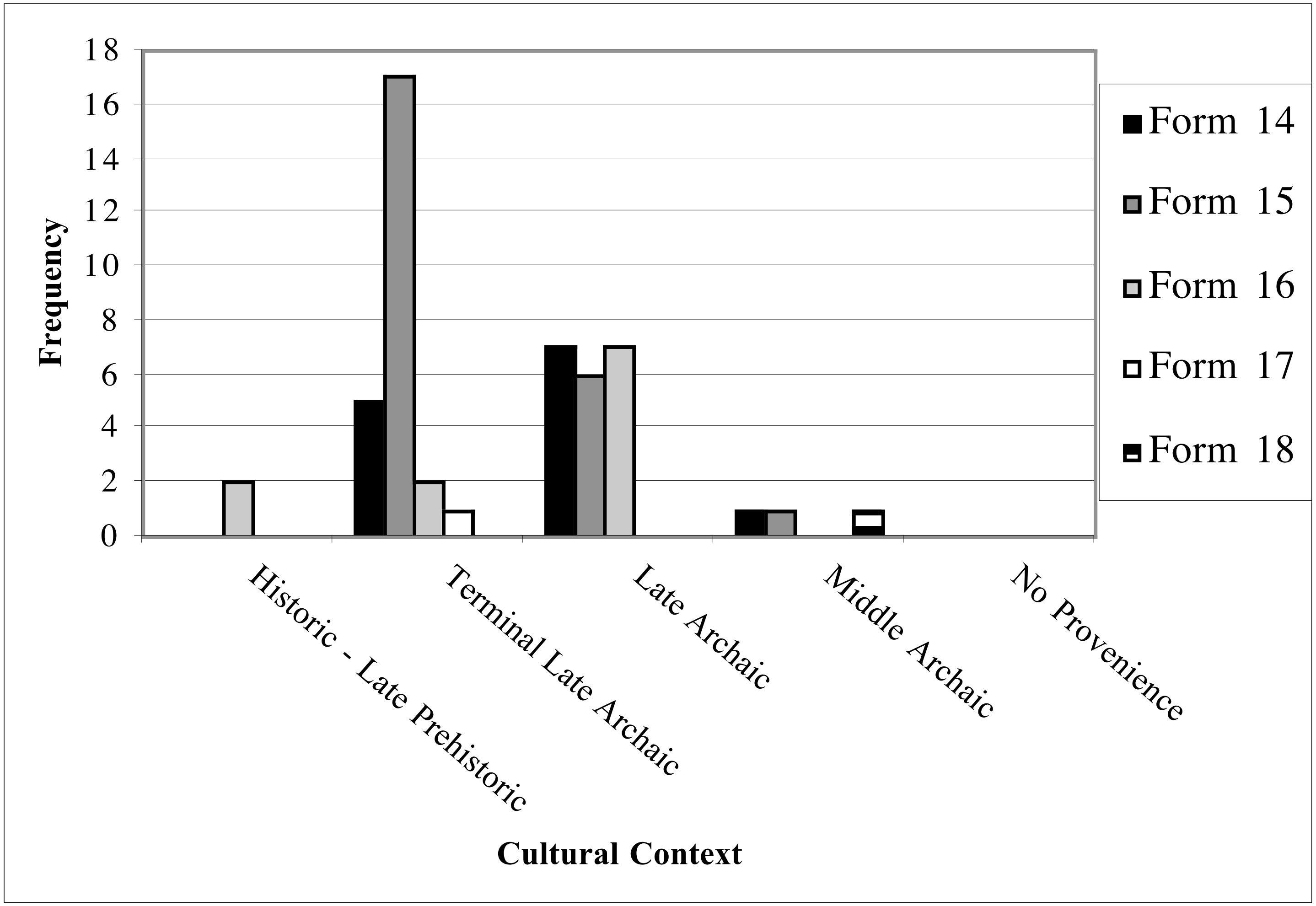

Figure 25: Diachronic Comparison of Frequency Distribution for Undecorated Bead Forms 14 – 18.

The second group of undecorated bead forms manufactured from mammal bone is from the small to medium end of range of source animals present in the collection sample and includes Forms 19 – 23. The group consists of short (<20 mm), medium width (10 – 20 mm) forms differentiated on the basis of wall thickness and degree of further surface alteration following detachment of the bead blank. Thin-walled forms include those with minimal surface alteration (Form 19) and longitudinal scraping (Form 20). Other forms with evidence of scraping followed by subsequent grinding and/or polishing steps during manufacturing include a medium thick-walled (Form 21) and thick-walled (Form 22) variant. A final thick-walled variant is similar to Form 19, but manufactured from thick-walled skeletal elements of medium-sized mammals. While this group of forms is represented in all contexts documented in this analysis, about 44 per cent of its 9 specimens come from Terminal Late Archaic context in strata 3 – 9. One-third of its specimens also come from Late Archaic context in strata 10 – 11. The remainder is evenly split between Historic – Late Prehistoric and Middle Archaic contexts.

A minimally modified, thin-walled specimen is the single representative of Form 19 that contributes one of the total of 9 specimens in this group of short, medium width bead forms. It occurred in Terminal Late Archaic context and was manufactured from a jackrabbit tibia. This specimen is burned to the point of calcination, obscuring its wear signature.

A single thin-walled specimen that was further modified by longitudinal scraping is the only representative of Form 20. It was also manufactured from a jackrabbit tibia and occurred within Late Archaic context in strata 10 - 11. Use wear present on this specimen was consistent with contact from silica-rich plant material.

Short, medium-width, medium thick-walled beads derived from bone blanks that were further modified by longitudinal scraping constitute Form 21. This form is represented by two beads from Terminal Late Archaic context and were both fashioned from small to medium-sized carnivore long bone blanks. One of them has use wear consistent with dry hide contact. The other's use wear is consistent with contact from silica-rich plant material.

Form 22 is the largest constituent of the group of short, medium-width undecorated beads and, in addition to longitudinal scraping, exhibits final shaping or finishing by grinding or polishing. Four of its medium thick-walled beads contribute 44 per cent of this group of beads. Two of the specimens are from Terminal Late Archaic context in strata 3 – 9, a single specimen is from more recent Historic – Late Prehistoric context, and the final specimen is from Middle Archaic context below stratum 11. All were fashioned from mammals in the small to medium-sized range, with at least two being identifiable as carnivores. The other two specimens were identifiable only as originating with mammals in the medium-sized body range. Invasive polish typical of contact with dry hide, wet hide, or hide with hair is found on all four of the specimens in this form.

Short, medium-width beads from thick-walled blanks that were had minimal further modification make up Form 23, the final member of this group of beads. Two specimens were found in Late Archaic context in strata 10 – 11. Both were made from medium to large carnivore long bones. One of these specimens is too heavily weathered for identification of any of its original use wear characteristics. The other specimen exhibits use wear typical of contact with dry hide.

A graphic representation of the diachronic frequency of undecorated beads in Forms 19 - 23 is shown in Figure 26.

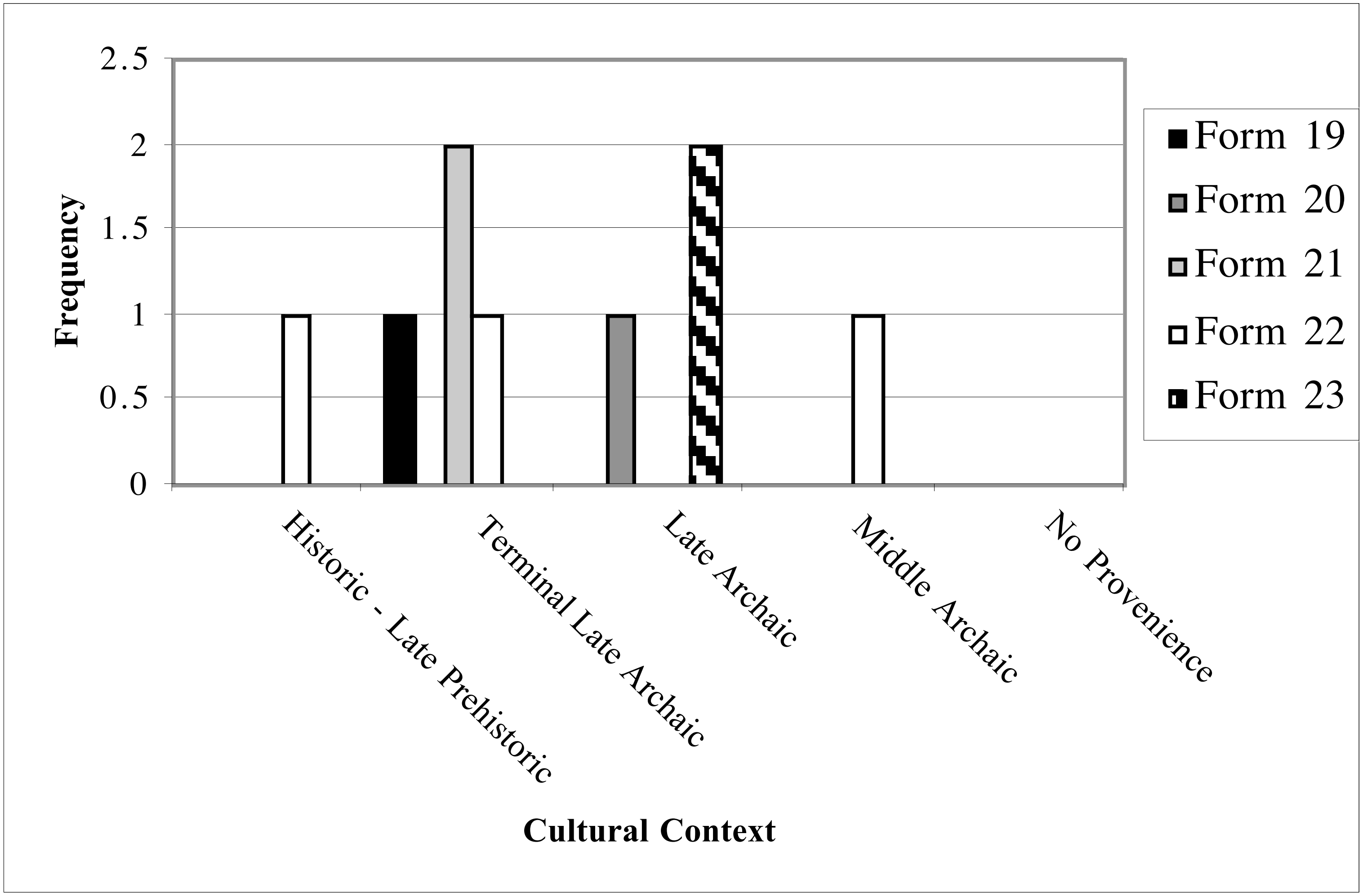

Figure 26: Diachronic Comparison of Frequency Distribution for Undecorated Bead Forms 19 – 23.

The third group of undecorated bead forms manufactured from mammal bone is from derived from a wide range for source animals present in the analyzed sample. This group includes Forms 24 – 31. The group consists of medium length (20 – 30 mm) forms differentiated on the basis of wall thickness and degree of further surface alteration following detachment of the bead blank. Thin-walled forms include narrow width (<10 mm) beads with minimal surface alteration (Form 24), longitudinal scraping (Form 25), and scraping followed by subsequent grinding and/or polishing steps during manufacturing (Form 26). Other narrow width forms with evidence of scraping followed by subsequent grinding and/or polishing steps during manufacturing include a medium thick-walled (Form 27) and a thick-walled (Form 28) variant. Medium width (10 – 20 mm) forms are similar and include a medium thick-walled form with longitudinal scraping (Form 29), a medium thick-walled form with final grinding and/or polishing evidence (Form 30), and a final thick-walled variant with minimal additional surface modification (Form 31). While this group of forms is represented in all contexts documented in this analysis except the Historic – Late Prehistoric, about 41 per cent of its 29 specimens come from Late Archaic context in strata 10 – 11. Thirty-eight per cent of its specimens are from Terminal Late Archaic context in strata 3 – 9. The final 21 per cent of its specimens comes from Middle Archaic context below stratum 11.

Minimally modified, thin-walled specimens make up Form 24 that contributes 25 per cent of the specimens in this group. A majority of these items (five specimens) originated in Late Archaic strata. The Terminal Late Archaic and Middle Archaic contexts are each represented by a single specimen. All of the specimens in this form are in the rabbit size range, with all identified as either cottontail or jackrabbit. While jackrabbits were the source taxon for slightly more than half of the beads in this form, most of the Late Archaic Form 24 beads were manufactured from cottontail tibiae.

Slightly more than half of the specimens in this form exhibit wear consistent with dry hide contact. Two of the Form 24 specimens have wear more consistent with contact by silica-rich plant materials.

Thin-walled specimens additionally modified by longitudinal scraping make up Form 25. This form also contributed 25 per cent of the total of 28 specimens in this group of medium length bead forms. All except one of the specimens from this form were manufactured from jackrabbit long bones. The remaining specimen was manufactured from a cottontail rabbit.

Similar to Form 24, most (5) of the Form 25 specimens originated within Late Archaic context. They included the cottontail specimen and four fashioned from jackrabbit. Two jackrabbit specimens came from Terminal Late Archaic strata. Except for one Late Archaic specimen, use wear in the Form 25 specimens is primarily consistent with contact by contact from dry hide. The single Late Archaic exception exhibited use wear typical of silica-rich plants.

A more narrow range of taxa was used for raw materials for Form 26, a thin-walled medium length narrow bead form found exclusively in the Middle Archaic context below stratum 11. Except for the longer length, this form is very similar to Form 16 in manufacturing techniques represented, with the surface and ends being ground or polished as a final shaping step. Two specimens of beads fashioned from fox-sized canids were found, as was a single specimen from a fox or jackrabbit sized unidentified medium mammal taxon. Use wear for Form 26 specimens is consistent with that previously mentioned for Form 25. Both canid specimens have wear caused by contact with silica-rich plants. Wear from dry hide was documented for the specimen of unidentified mammal.

An unidentified medium-sized carnivore taxon was used for raw materials for Form 28, a thick-walled medium length narrow bead form found in the Late Archaic context in strata 10 – 11. Except for the greater wall thickness, this form is very similar to Forms 26 and 27 in manufacturing techniques, as the ends are ground or polished as a final shaping step. Use wear for the Form 28 specimen is consistent with wear caused by contact with wet hide.

Medium thick-walled specimens modified by longitudinal scraping make up Form 29, a form very similar to Form 25, but differing in the greater wall thickness and width. A single specimen of Form 29 bead originated within Terminal Late Archaic context and was manufactured from coyote or domestic dog. Use wear in the Form 29 specimen is consistent with contact by contact from dry hide.

An unidentified medium-sized carnivore taxon and large fox-sized canid were used for raw materials for Form 30, a medium thick-walled medium length narrow bead form found in the Terminal Late Archaic context in strata 3 – 9. An unidentified medium-sized carnivore taxon was also used for Form 30 bead raw materials in Middle Archaic context below stratum 11. Except for the greater width, this form is very similar to Form 27 in manufacturing techniques, as the ends are ground or polished as a final shaping step. Use wear for the Form 30 specimen is consistent with wear caused by contact with dry hide.

The two specimens of Form 31 beads were manufactured from coyote or domestic dog and a deer or pronghorn-sized artiodactyl. This thick-walled form was documented in Terminal Late Archaic context in the Arenosa Shelter sample. Similar to Form 24, these specimens have minimal additional surface modification following detachment of the bead blank. Use wear for the artiodactyl-derived specimen was consistent with contact from silica-rich plant materials. The other specimen did not have documented use wear.

A graphic representation of the diachronic frequency of undecorated beads in Forms 24 - 31 is shown in Figure 27.

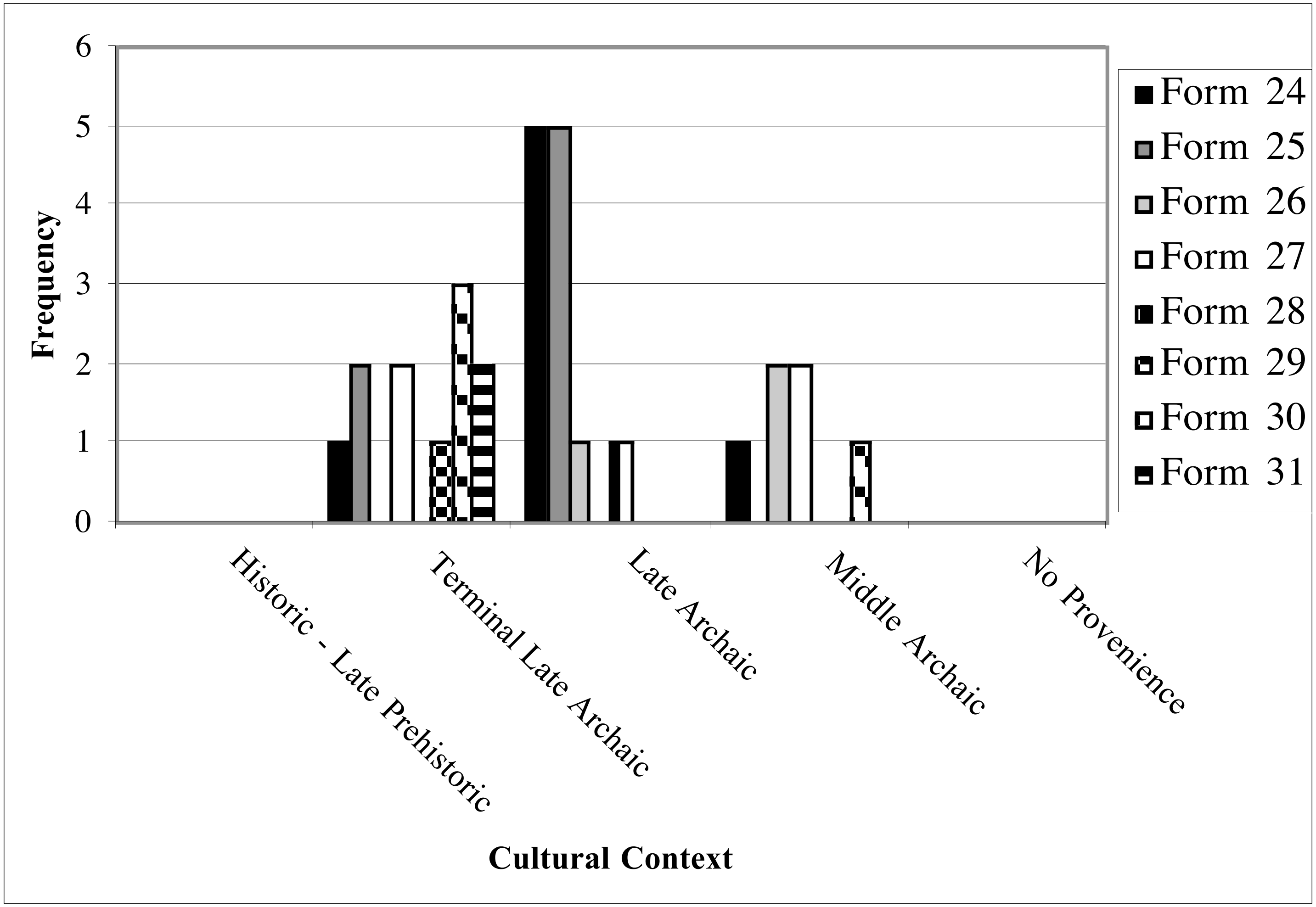

Figure 27: Diachronic Comparison of Frequency Distribution for Undecorated Bead Forms 24 – 31.

The final group of undecorated bead forms manufactured from mammal bone is from derived from the medium to large range for source animals present in the analyzed sample. This group includes Forms 32 – 36. The group consists of long (>30 mm) forms differentiated on the basis of wall thickness and degree of further surface alteration following detachment of the bead blank. The single thin-walled form includes narrow width (<10 mm) beads with minimal surface alteration (Form 32). Another long bead form (Form 35) exhibiting minimal surface alteration is of medium width and fashioned from thick-walled mammal blanks. A medium width form (10 – 20 mm) from a medium-thick walled mammal blank further modified by longitudinal scraping (Form 33) is among the long beads in this group. Other medium width forms with evidence of longitudinal scraping followed by subsequent grinding and/or polishing steps during manufacturing include a medium thick-walled (Form 34) and a thick-walled (Form 36) variant. While this group of forms is represented in all contexts documented in this analysis except the Historic – Late Prehistoric and Middle Archaic contexts, about 66 per cent of its 9 specimens come from Terminal Late Archaic context in strata 3 – 9. A single specimen is from Late Archaic context in strata 10 – 11. The final 22 per cent of its specimens lack provenience.

The minimally modified, thin-walled long narrow Form 32 bead contributes a single specimen in this group. It is the single long bead that originated in Late Archaic strata. It was identified as being manufactured from a jackrabbit tibia. This specimen exhibits wear consistent with dry hide contact.

Form 33, a long, medium-width bead exhibiting longitudinal scraping, was represented by two specimens. Both specimens were manufactured from domestic dog or coyote. One specimen was found in Terminal Late Archaic context in stratum 3 – 9. The other specimen lacked provenience data. The Terminal Late Archaic specimen was burned, obscuring its wear signature, while the other had use wear typical of contact with dry hide.

Three specimens of Form 34 long, medium-width beads were manufactured from medium thick-walled mammal bone blanks obtained from gray fox, domestic dog or coyote, and a large fox-sized canid. Specimens were found primarily in Terminal Late Archaic context in stratum 3 – 9. Use wear for each was consistent with dry hide.

Long, medium width beads (Form 35) were fashioned form thick-walled elements and had minimal additional surface modification. The single specimen was manufactured from a deer or pronghorn-sized artiodactyl rib. The bright invasive polish with limited rounding of the ends was consistent with contact from silica-rich plant materials.

The final bead form in this group (Form 36) was a long, medium-width tubular form manufactured from thick-walled elements and, similar to Form 34, has evidence of longitudinal scraping followed by subsequent grinding and/or polishing steps during manufacturing. The single specimen of Form 36 in the sample was made from a fox or raccoon-sized carnivore. It is slightly burned and has highly polished ends. The use wear is bright and invasive, typical of contact from dry hide.

A graphic representation of the diachronic frequency of undecorated beads in Forms 32 - 36 is shown in Figure 28.

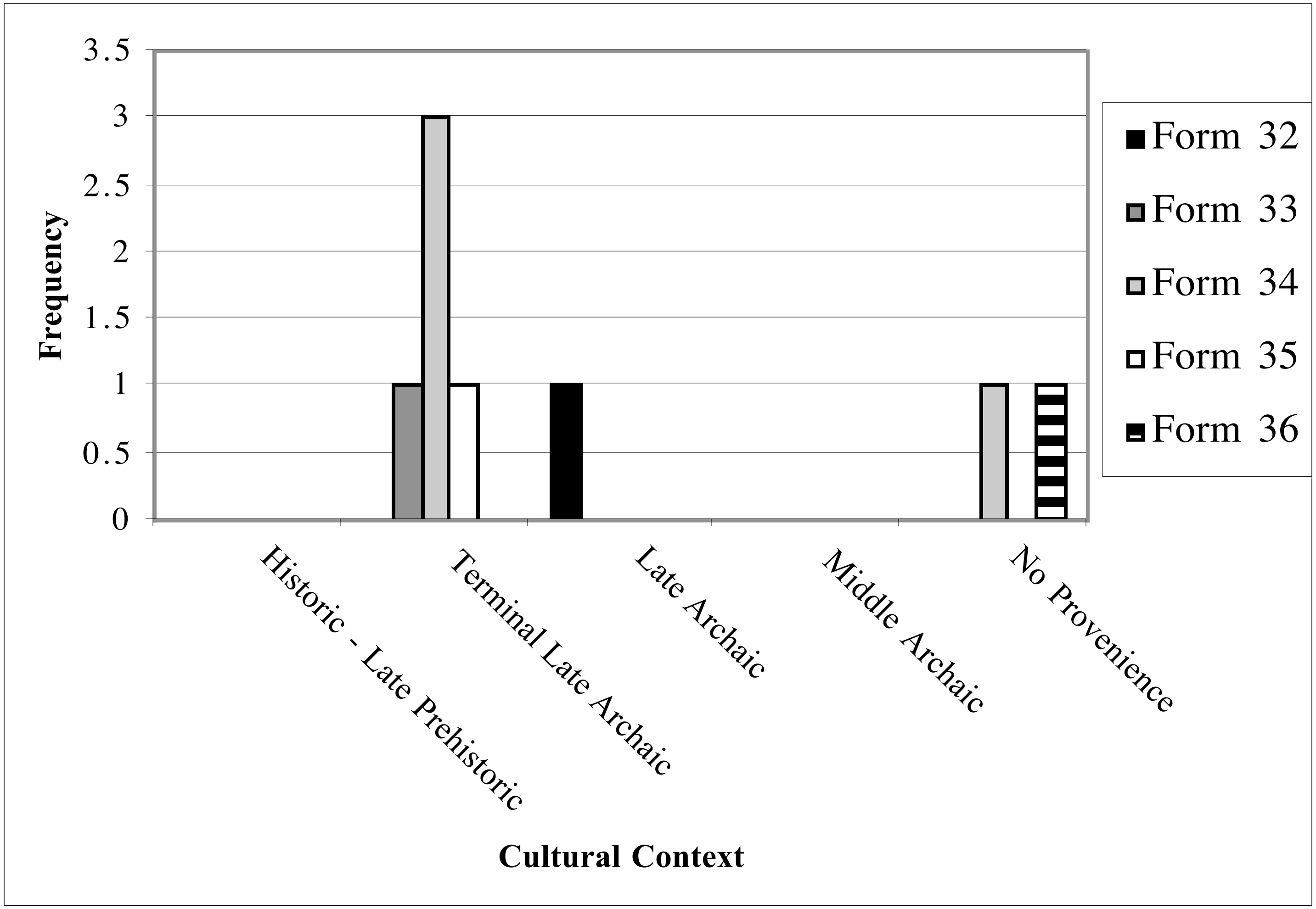

Figure 28: Diachronic Comparison of Frequency Distribution for Undecorated Bead Forms 32 – 36.

Eight preforms for bead forms or their manufacturing failures were found in the full range of cultural contexts represented in the Arenosa Shelter sample. Preforms documented in the collection are typically long, in excess of 30 mm, with several representing significant portions of the diaphyses from long bones that were used as raw materials.

A single preform and a preform manufacturing failure for Form 1 undecorated beads were found in Terminal Late Archaic context in strata 3 – 9. Both were manufactured from artiodactyl phalanges that had been longitudinally scraped. Limited grinding was also present on the articular portions present in the specimens.

A single preform for an undecorated Form 3 bead was found in Middle Archaic context below stratum 11. It was manufactured from a large hawk proximal tibiotarsus and exhibits longitudinal scraping on its distal half. A second annular groove is incised into the diaphysis 6.5 mm proximal to the terminal groove and snap fracture, possibly presaging detachment of the next Form 3 bead.

Two undecorated Form 13 bead preforms manufactured from an unidentified large bird taxon were documented in the sample, one in Late Archaic context and the other in Middle Archaic context. The Late Archaic specimen was of indeterminate long bone that had been scraped prior to removal of the blank by grooving and snapping. The Middle Archaic specimen was identifiable as a medial tibiotarsus diaphysis that had been similarly prepared.

A bead preform was recovered from Late Archaic context in strata 10 – 11 and represented an undecorated Form 25 bead being manufactured from a jackrabbit tibia diaphysis. This preform for a medium-length, narrow bead exhibited longitudinal scraping to smooth and shape its cross-section and the remnants of a single annular groove incised 20 mm from the proximal end.

A specimen from a generalized Late Archaic – Middle Archaic context in strata 9 – 19 represents a preform for a Form 29 or Form 30 undecorated bead. It was the preform for a medium length bead being manufactured from a dog or coyote humerus diaphysis

The final bead preform recognized in the Arenosa Shelter sample was from Terminal Late Archaic context and represents the manufacturing process for a Form 32 undecorated bead. This long preform was being fashioned from a juvenile carnivore radius and exhibits a terminal groove and snap fracture that removed the proximal epiphysis.

Thirty-one items of bone bead debitage were recognized during analysis of the Arenosa Shelter bone artifact sample. Almost two-thirds of these were identified as the remains of carnivores. Artiodactyls and birds make up almost all of the remainder, with a single specimen of unidentified mammal also being recognized. Four of the bead specimens did not originate within Terminal Late Archaic context in strata 3 – 9. Late Archaic specimens consist of a large hawk distal radius and a juvenile dog or coyote distal humerus. This canid specimen included the distal epiphysis and had been longitudinally scraped on the surface of the diaphysis. More than four sets of deep, transverse cutmarks were adjacent to the terminal groove and snap fracture on the canid humerus.

A Middle Archaic artiodactyl proximal phalange specimen of bead debitage was removed from a bead blank by grooving and snapping. This final non-Terminal Late Archaic bead debitage specimen lacked provenience. It was manufactured from a juvenile medium carnivore distal humerus diaphysis in the bobcat, coyote, or domestic dog size range. This specimen exhibited longitudinal scraping proximal to the terminal groove and snap fracture. A medium, non-invasive polish consistent with contact from silica-rich plants was also present on this specimen.

The remaining 27 bone bead debitage specimens were from Terminal Late Archaic context and represented a variety of bird, carnivore, artiodactyl, or unidentified mammal taxa. Three Terminal Late Archaic bead debitage specimens were recognizable as medium to large hawk. One was smaller than the others at 16.5 mm in length and was the distal epiphysis of a medium – large hawk right humerus. The element had been longitudinally scraped prior to initiation of the terminal groove and snap fracture. The other two hawk debitage specimens were longer, 30 and 43 mm respectively, and represented an ulna distal diaphysis and tibiotarsus diaphysis that included the distal epiphysis. The ulna specimen was from a large hawk, had been longitudinally scraped, and exhibited 4 deep transverse cutmarks immediately adjacent to the terminal fracture. The tibiotarsus specimen had longitudinal scraping on its lateral aspect distally, with remnants of two groove and snap fractures on its proximal end.

A fourth Terminal Late Archaic bead debitage fragment from a bird was attributable to *Phalacrocorax* sp., a cormorant. This tibiotarsus diaphysis included the distal epiphysis and exhibited longitudinal scraping.

One Terminal Late Archaic specimen of bead debitage was recognizable as originating with a medium to large mammal, but could not be identified further. This rib diaphysis fragment had at least five grooves incised at 3 mm intervals proximal to the terminal groove and snap fracture. It exhibited a bright, non-invasive polish on high points on its dorsal aspect, with no polish ventrally. At the higher magnification (30 – 70x) used in the current study, this polish included sharp-edged transverse striations consistent with contact from silica-rich plant.

Three Terminal Late Archaic specimens are artiodactyl phalanges, one from a juvenile individual. Two of these specimens included the proximal epiphysis that had been removed from the bead blank by grooving and snapping. The other was a distal epiphysis that had been similarly removed following longitudinal scraping of the element. A fourth artiodactyl proximal phalange epiphysis, more identifiable and attributable to deer, included a grinding modification on the terminal fracture and had areas of slightly non-invasive wear consistent with contact by silica-rich plant materials.

The remaining 18 Terminal Late Archaic bead debitage specimens were recognizable as remains of carnivore taxa. A single radius distal epiphysis specimen was identifiable only to Carnivora due to its poor preservation and had been removed from the blank by a groove and snap fracture. Two specimens of bead debitage attributable to bobcat were identified due to included epiphyses, one from a distal femur, and the other from a distal humerus. The femur specimen was poorly preserved, but exhibited several sets of parallel grooves adjacent to the terminal groove and snap fracture. The humerus specimen exhibited longitudinal scraping on its surface and limited polish on high points. It also had 20 – 25 sets of deep cutmarks adjacent to the annular groove and snap fracture that formed the terminal fracture.

Three of these carnivore Terminal Late Archaic debitage specimens were attributable to the family Canidae, but could not be further identified. One was a distal humerus diaphysis from a juvenile individual that had been longitudinally scraped prior to removal of the epiphyses. It had multiple deep transverse cutmarks adjacent to the terminal fracture. A second juvenile canid specimen was from a medium dog or coyote sized proximal ulna that included the epiphysis. It exhibited longitudinal scraping on the surface of its diaphysis. The last canid specimen was from a proximal femur, including the epiphysis. It had five or more deep transverse cutmarks or partial grooves adjacent to the terminal groove and snap fracture, but no further modification.

All other Terminal Late Archaic canid bead debitage fragments were attributable to the genera *Canis*, *Vulpes*, or *Urocyon*. Eight were recognizable as long bones from either coyote or a similarly sized domestic dog. Five of these specimens were from tibiae, with four including the epiphyses. Four of these dog or coyote specimens had been longitudinally scraped prior to detachment of the bead blank. The fifth was from a juvenile individual and was extremely pitted. It had deep transverse cutmarks adjacent to the terminal groove and snap fracture.

One specimen was identified as a subadult large fox, dog, or coyote distal tibia that included a partially fused epiphyseal plate and epiphysis. The diaphysis was longitudinally scraped and exhibited five or more sets of transverse deep cutmarks adjacent to the terminal fracture.

The last three Terminal Late Archaic canid bead debitage fragments were attributable to the fox genera. Two specimens of fox distal tibia diaphyses were identified as *Vulpes* sp. One *Vulpes* specimen had been longitudinally scraped and had two sets of partial annular grooves and deep transverse cutmarks adjacent to the terminal fracture. The other *Vulpes* specimen had been minimally modified. The last fox specimen was a proximal humerus with epiphysis that was attributable to either gray fox or a similarly sized *Vulpes* sp. It had longitudinal scraping, but little additional surface modification.

A graphic representation of the diachronic frequency of bead debitage in is shown in Figure 29.

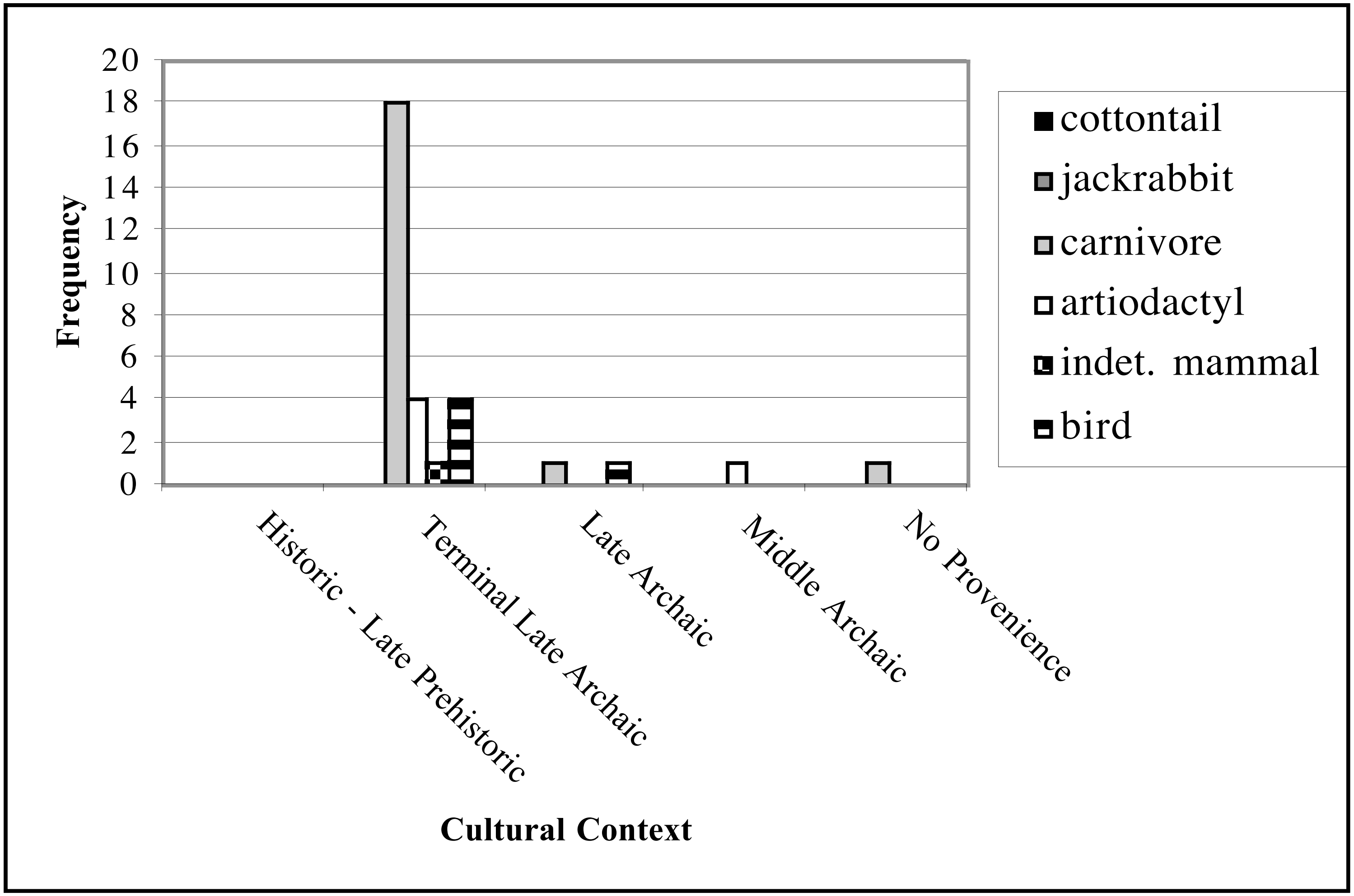

Figure 29: Diachronic Comparison of Frequency Distribution for Bone Bead Debitage in Arenosa Shelter Sample.

Bone tubes and preforms will be considered separately from bead debitage within the ornament class because they differ in manufacturing and use wear characteristics and may have a different function. Bone tubes were found in both Late Archaic and Terminal Late Archaic contexts. Documented in the sample were 37 examples of bone tubes or bone tube preforms manufactured from an array of bird and mammal taxa.

Within the 16 Late Archaic specimens, nine are avian. Three of these are attributable to hawk or falcon-like birds and include wing elements from small to large hawks. These hawk elements have been longitudinally scraped or ground and have polish on high points or ends that is consistent with contact from dry hide or silica-rich plants. The six remaining Late Archaic specimens of avian bone tubes are identified only to Aves. One is from a small hawk-sized radius diaphysis that had been longitudinally scraped. It exhibited invasive polish consistent with dry hide contact on the ends only. Five of them are from large bird long bones, although the exact element could not be identified. Two of these were burned and did not exhibit obvious wear. The other three Late Archaic large bird bone tubes were longitudinally scraped, but without obvious wear.

A single Late Archaic bone tube specimen was identifiable only as a juvenile medium-sized mammal ulna diaphysis. It had been treated in a similar fashion to the previously mentioned large bird tubes that were only scraped but not obviously worn. A single Late Archaic bone tube fashioned from a cottontail tibia diaphysis was longitudinally scraped and then ground on one end, following detachment of the bone tube from the debitage. It exhibited very limited medium invasive polish with slight end rounding consistent with silica-rich plant material wear.

The other five Late Archaic bone tubes or bone tube fragments were manufactured from jackrabbit long bone diaphyses that included two radii, two tibiae, and a phalange. Four of these specimens exhibited wear from either silica-rich plants or dry hide. Wear from siliceous stone was also evident on one of the tibiae. The phalange and one of the radii had also been longitudinally scraped.

The 19 complete or fragmentary bone tubes from Terminal Late Archaic in the sample had a slightly broader range of source taxa that added an artiodactyl and at least three carnivores to the range. Five of these specimens were avian, all from hawk long bone elements. A single bone tube fashioned from a proximal tibiotarsus diaphysis that was identified as originating from a very large hawk or eagle-sized bird in the family Accipitridae exhibited longitudinal scraping and had medium non-invasive polish on high points consistent with silica-rich plant material wear. Four other specimens were identifiable as from long bones of hawks in the genus *Buteo* that had minimal surface modification. Two were fashioned from wing bones, an ulna and radius, respectively. They exhibited non-invasive polish on high points consistent with contract from silica-rich plants. A third was from a tibiotarsus and retained a remnant of the fibular crest. The other specimen was not identifiable to a specific element.

The remaining 13 specimens of Terminal Late Archaic context bone tubes or their fragments were manufactured from mammal long bones. A single artiodactyl tube fragment was documented in the sample that had been scraped and exhibited bright, invasive polish from dry hide contact. All other Terminal Late Archaic context complete or fragmentary bone tubes were manufactured from either carnivore or lagomorph long bone diaphyses.

The six carnivore specimens included those fashioned from a fox in the genus *Vulpes*, domestic dog or coyote, and unidentified taxa in Carnivora. The domestic dog or coyote specimen was from a radius with minimal surface modification. The fox specimen was identified as an ulna diaphysis fragment that had been longitudinally scraped, but with no additional smoothing. It exhibited slight end rounding and medium non-invasive polish consistent with silica-rich plant material wear. Remaining carnivore bone tubes include two from tibiae, a radius, and a humerus. One of the tibia specimens is weathered, but retains evidence of surface modification by longitudinal scraping and has medium invasive polish and micro-pitting consistent with wear from dry hide. The remaining tibia specimen had minimal surface modification, but did evidence end rounding and slight polish on the terminal fractures. Two of the Terminal Late Archaic carnivore-derived bone tube specimens are from juvenile individuals and include tubes made from radius and humerus diaphyses. The humerus specimen had been longitudinally scraped. The radius specimen had no technologically related surface modification. Neither of theses specimens had documented wear.

The seven Terminal Late Archaic bone tubes that were manufactured from lagomorphs included one from cottontail and six from jackrabbits. All of the jackrabbit specimens were fashioned from tibia diaphyses, while the cottontail specimen was manufactured from a radius diaphysis. The cottontail bone tube specimen was not modified beyond grooving and snapping that formed its terminal fractures, but did have bright invasive polish with slight end rounding that were consistent with dry hide wear. The jackrabbit-derived bone tube fragments included one manufactured from a juvenile individual. Modifications to all but one of these jackrabbit specimens included longitudinal scraping. One of these specimens was also ground. Two of these adult specimens had wear present; one consistent with dry hide and the other consistent with silica-rich plants.

Two additional Terminal Late Archaic specimens were considered to be preforms for bone tubes. Both of these were from canid taxa. One was identified only to family and was a weathered distal diaphysis from a juvenile fox-sized canid tibia. The only modification to this specimen was an annular groove incised 15 mm from the distal terminal groove and snap fracture. The other specimen was from a domestic dog or coyote humerus that had been longitudinally scraped.

A graphic representation of the diachronic frequency of bone tubes and their preforms in is shown in Figure 30.

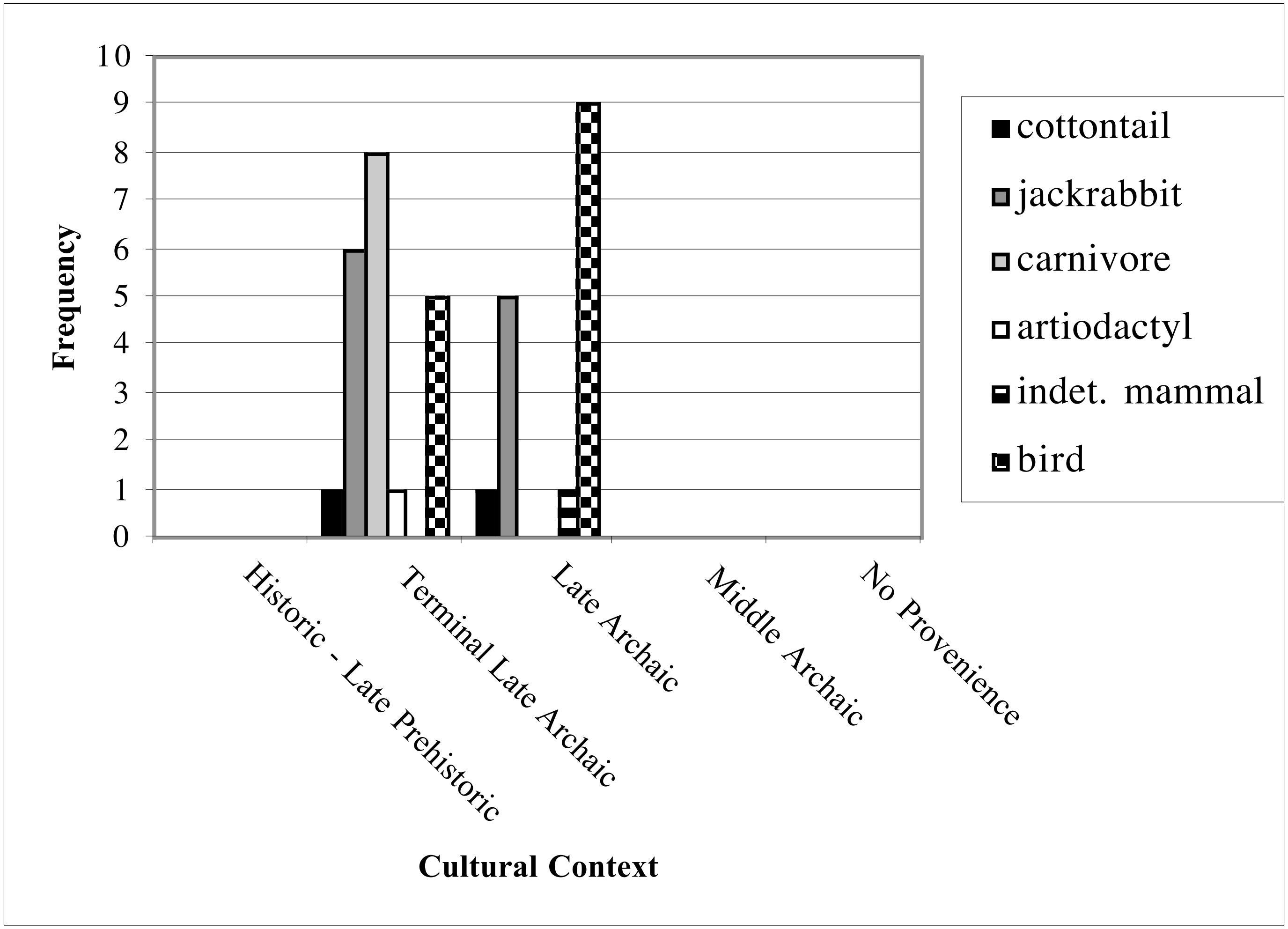

Figure 30: Diachronic Comparison of Frequency Distribution for Bone Tubes and Preforms in Arenosa Shelter Sample.

Implement Forms and Manufacturing Byproducts

Six forms of antler implements and 25 forms of bone implements were identified from specimens in the bone artifact sample from Arenosa Shelter on the basis of observations of taxonomic, metrical, technological, and use wear data. These included a further refinement of antler implement definition that provided several additional forms of antler tine tool that were based on tip morphology and use wear data. Mirroring the situation with ornaments from the sample, frequency data indicate that bone and antler implements were most numerous in the site's Terminal Late Archaic cultural context. Almost 60 per cent (184 items) of the implements in the analyzed sample originated from within strata 3 – 9. In contrast to the ornaments, the second highest frequency of implements in the analyzed sample was from Middle Archaic context, with about 18 per cent (55 items) of its contents coming from the zone between stratum 12 and stratum 30. Late Archaic context in strata 10 and 11 accounted from about one-third less total artifacts, with about 12.5 per cent (42 items) of the total implements in the analyzed sample. Historic and Late Prehistoric implements from above stratum 3 provided only about six per cent (21 items) from the sample. Slightly more than four per cent (14 items) lacked provenience in the analyzed sample. Almost 64 per cent (7 items) of the manufacturing or refitting debitage was found in Terminal Late Archaic context, with lesser amounts being found in Late Archaic or Middle Archaic context or lacking provenience completely. Frequency and cultural context for specific implement forms and manufacturing byproducts are found in Table 6.8.

Thirteen separate complete or separate deer antler implements were identified in the Arenosa Shelter bone implement sample from Terminal Late Archaic to Middle Archaic contexts. These included six separate defined forms that were based on observed morphology, anatomical location of raw material, manufacturing characteristics, and use wear, as previously defined in Tables 6.1 and 6.2.

Most of these artifacts (7) were from Middle Archaic context beneath stratum 11 and included a wide variety of antler tine tool forms (5) used for functions that were interpreted as varying from woodworking to flint-knapping based on crushing, striations, and use wear present. Antler tine tools interpreted as chisels were found in all three Archaic contexts where antler tools were present. These tools were defined on the basis of bevels ground into one end, with distinctive wood polish that included visible osteons present on the bevel. Scraping was also used to shape the Middle Archaic and Late Archaic specimens.

Two additional antler tine tools with beveled tips were recovered from Middle Archaic contexts. Both were heavily weathered or carnivore-ravaged, but retained sufficient surface characteristics for use wear and manufacturing characteristics to be deduced. The tip bevel in at least one case was done by grinding. The tools had a 6 to 9 mm wide profile with an oval to round cross section. The tine body was longitudinally scraped to shape on one of these. A bright non-invasive polish of unknown source was also found on one specimen.

Two antler tine fragments from Middle Archaic context were identified as pressure flakers on the basis of broad or blunt, rounded tip profile characteristics, tip battering, tear-out of tip or lateral edges, or concentrations of striations at the tip and adjacent areas along the lateral edges. The striations have wear characteristics produced by siliceous stone.

Two other antler tine tools with rounded tips were found, one each in Late Archaic and Middle Archaic contexts. The tips of each were ground to a gently rounded profile with a round cross section. The Late Archaic specimen had use wear from dry hide that is recognized due to the presence of weathering damage. Although the Middle Archaic specimen was burned, it had evidence remaining of wear from hide with hair.

Another poorly preserved antler tine tool fragment from Middle Archaic context was heavily weathered and carnivore ravaged. It had no remaining use wear polish, but did show manufacturing evidence of longitudinal scraping.

Only the tool form fashioned from antler beams was not included in Middle Archaic context. These tools were interpreted as antler billets used in soft hammer percussion flaking. Three of these tools were identified from Late Archaic contexts and included two that were relatively complete and one identifiable fragment. The two almost complete specimens were at least 125 mm in length and 20 to 32 mm in lateral direction, with broadly rounded ends that were ground to shape. The end of one of the billets has a slightly invasive polish similar to that produced by dry hide. Longitudinal scraping was used to further shape the billet prior to use. The ends of the two almost complete specimens have deep cutmarks on the end itself or longitudinal cutmarks, grooves or striations adjacent to the ends. The grooves and striations have characteristics produced by siliceous stone.

The remainder of the implements was fashioned from mammal, turtle, or fish bone or, in one case, a ganoid scale from a large fish. For narrative purposes, tools that underwent an informal modification process will be considered before those that underwent a more formal manufacturing process. Tools that underwent a less formal manufacturing process are termed informal tools for this study. These include utilized bone fragments and expedient tools that underwent minimal additional modification before use (Johnson 1987:108).

The informal tools show evidence of minimal modification of mammalian skeletal elements or, in one case, a utilized fish scale. Raw material for the mammal bone-based tools was primarily helically fractured long bone elements that were byproducts of butchering, marrow extraction, or bone grease production. Nine informal tools were identified in the Arenosa Shelter bone artifact sample analysis, found in all four cultural contexts. Six of these tools were from Terminal Late Archaic context in strata 3 – 9. A single utilized scale from a large *Lepisosteus* sp. (gar) fish was found in Historic – Late Prehistoric context above stratum 3. Single informal tools from Late Archaic and Middle Archaic contexts were also found. Except for the gar scale and a single modified carnivore ulna, all of these tools were fashioned from fragments of artiodactyl elements.

In addition to the utilized gar scale from Historic – Late Prehistoric context, four of the six Terminal Late Archaic specimens were identified as butchering tools. Helically fractured fragments of two tibiae, one humerus, and an indeterminate long bone were utilized in butchering and show wear from use in cutting meat. Three of these specimens were modified by percussion flaking to remove bone material along a lateral or distal cutting edge that shows subsequent use wear. One of the tibia specimens was scraped to shape prior to having its cutting edge reshaped by percussion flaking. The other tibia specimen was utilized with no resharpening.

An additional artiodactyl-derived informal tool from Late Archaic context was identified as a cutting tool fashioned from a helically fractured humerus fragment that was subsequently grooved medially and distally. One lateral edge shows two small areas of unifacial hard hammer percussion flaking near its end that have use wear from what was probably short-term cutting of meat.

The remaining informal tools fall into two morphological forms. One of these forms was apparently used in hide working. A single Terminal Late Archaic specimen fashioned from an artiodactyl radius diaphysis was derived from byproducts of the manufacturing process for formal tools and shows evidence of blank removal by grooving and snapping, with removal of the periosteum layer by longitudinal scraping. Middle portions of the lateral edges were further shaped by hard hammer percussion to produce a scalloped edge profile. The lateral edge ends are slightly rounded and polished, as are the high points of the scalloped edges. Use wear associated with this implement fits the pattern of contact with hides containing hair.

The remaining two informal tool specimens have been modified into morphological forms that have projecting narrow working areas with an oval cross section. For the purposes of this analysis, these tools are termed informal bone tool spatulates. A Terminal Late Archaic specimen fashioned from a helically fractured carnivore ulna has utilization wear on its distal fracture. The periosteum was scraped off and the distal fracture and much of the elements ventral aspect have a use wear polish consistent with contact by hides with attached hair. The single informal tool of this type from Middle Archaic context was fashioned from a weathered, helically fractured artiodactyl tibia that was scraped and ground to its final shape. The working area on this specimen has use wear consistent with contact by silica-rich plants.

Implements undergoing more extensive and formalized manufacturing processes and the byproducts of those processes will now be considered. Approximately 300 individual items in the analyzed Arenosa Shelter bone artifact sample represented complete or fragmentary formal tools and their manufacturing byproducts. Twenty-four separate artifact forms were defined during the analysis, along with several additional preforms, manufacturing debitage, and refitting debitage.

Long tool forms were the most frequent and their morphology differed most importantly in the width of the tip section. Similar to the expedient tools, most of the formalized long tool forms were fashioned from artiodactyl long bones. Many of these were manufactured from the metapodia of the lower legs, either the metacarpal or metatarsal. Some tool forms used metacarpals almost exclusively as their raw material, among them the defined awl/bodkin, bodkin, and bodkin/perforator forms. Other forms used the metatarsals in many instances where the raw material source could be anatomically identified to a reliable degree, including for many spatulates. Some specific tool forms used the robust pectoral or dorsal spines of fish species, such as the blue catfish pectoral spines that formed the basis of the catfish spine spatulate and perforator forms. The exact manufacturing process and wear resulting from use varied considerably within many of these formalized tool forms.

Description of the formalized tool forms will begin with the metacarpal-derived forms. The 14 specimens of the awl/bodkin form were found primarily in Terminal Late Archaic context in strata 3 – 9, although specimens also occurred in earlier Late Archaic and Middle Archaic contexts. Eleven fragmentary Terminal Late Archaic awl/bodkins were fashioned from deer or unspecified artiodactyl long bone fragments, that included definite metacarpal, generalized metapodial, and indeterminate long bone fragments. A single Late Archaic awl/bodkin was manufactured from a deer metacarpal. The two Middle Archaic specimens were also manufactured from deer metacarpal bones.

Evidence drawn from fragmentary awl/bodkins that included all portions of the tool form indicates that the blank for this form was fashioned from the distal epiphysis and diaphysis of artiodactyl metacarpal bones by several methods. These included chopping, grooving and snapping, or an undetermined method used to remove unnecessary portions of the skeletal element from the blank. The blank was then further shaped by longitudinal scraping and/or grinding to refine the shape of the lateral edges and tip section. The tip section is typically oval in cross section, gently to sharply tapered, and sharp to rounded in end profile. The tip may exhibit a use-induced bevel or tear-out. Notably, on specimens that include the proximal portion of the tool, the lateral condyles have been extensively ground, exposing underlying cancellous bone. Use wear signatures for this form include wear from dry hide and silica-rich plants during the Middle Archaic and silica-rich plants during the Late Archaic. During the Terminal Late Archaic, use wear signatures included one instance of hide with attached hair, four of wood contact, and six instances of silica-rich plant contact.

Two Late Archaic specimens of awl/perforators were manufactured from distal diaphyses of medium to large mammal ulnas that had been grooved and snapped longitudinally and/or transversely to prepare the tool blank and then longitudinally scraped to final shape. These long narrow tools were had gently tapering tips with a round cross section, but the exact tip profile is unknown due to the absence of distal tips on both specimens. Use wear for both was consistent with dry hide contact.

Two small tools from Terminal Late Archaic and Middle context were interpreted as beamer/fleshers used in the removal of meat residue from hides. Similar to the expedient hide-working tool, these tools had wear signatures that were consistent with meat use. The Terminal Late Archaic form was closer to the expedient form in its manufacturing process and was based on a helically fractured artiodactyl indeterminate long bone fragment. A portion of this specimen was further modified by dynamic flaking to remove multiple bifacial flakes in forming a 9 mm wide beveled tip that showed use wear. The fragmentary Middle Archaic specimen was manufactured by grooving and snapping to remove the ventral margin of an artiodactyl scapula and then grinding it to a final shape. The lateral edge and distal tip had use wear from meat contact, a signature that is consistent with use in hide working to remove flesh remnants from the hide.

Another Terminal Late Archaic specimen was identified as the fragment of a flesher and was fashioned from the distal portion of an artiodactyl rib. This medio-distal tool has a 10 mm wide beveled tip section that was prepared by removal of multiple unifacial flakes across a transverse fracture. The polish present on the distal end of the tool indicates use wear from meat contact, a signature that is consistent with use in hide working. It should be noted that this specimen and the Terminal Late Archaic beamer/flesher are technologically more formalized than the similar expedient tools previously described and may represent intermediate positions in a continuum between expedient and more formalized tool manufacturing behavior exercised by the inhabitants of the Lower Pecos during this period.

Ten bodkin fragments were identified in the Arenosa Shelter bone artifact analysis. Each of these short, relatively broad tools was manufactured from distal artiodactyl metacarpal bones. Four of the specimens included the distal epiphysis. Three of the specimens were recognizable as deer. Similar in many respects to the awl/bodkin, the bodkin blank was prepared by chopping, grooving and snapping, or an undetermined method used to remove unnecessary portions of the skeletal element from the blank. Grinding of the lateral condyles into underlying cancellous bone was also employed in several instances to shape the proximal portion of the bodkin form. The distal end and lateral edges of the tools were further modified by longitudinal scraping and/or grinding to refine their shape. Tip profiles are variable, but typically relatively oval in cross section and sharply tapering. Identified use wear signature for the Historic – Late Prehistoric specimen is for silica-rich plant contact. For Terminal Late Archaic specimens, wood use wear is present on one specimen, with silica-rich plant contact wear on the other two. The three Late Archaic specimens include two that have silica-rich plant contact use wear and one that has wear from dry hides. All three Middle Archaic specimens have silica-rich plant contact use wear.

One unprovenienced fragment interpreted as bodkin manufacturing debitage was identified in the Arenosa Shelter bone artifact analysis sample. This metacarpal diaphysis had been modified by longitudinal grooving and snapping to remove a bodkin blank and had no further modification or use wear.

A single Middle Archaic specimen was identified as the distal tip of a bodkin/perforator manufactured from an artiodactyl metacarpal diaphysis. This sharply tapering distal section of a long, thin tool had an oval cross section that was 2 mm in width. Under magnification, the tip exhibited a slight tear-out from use. While the blank was prepared by an unknown method, it was possible to determine that the surface and edges of the tip were ground to final shape. A bright invasive polish, rounding of high points, and extensive fine, transverse, smooth-edged striations are consistent with dry hide wear.

Three fragments of narrow tools from Terminal Late Archaic contexts are interpreted as bone needles on the basis of morphology, manufacturing signatures, and remnant use wear. One of these was created from the distal ulna diaphysis of a coyote or domestic dog-sized canid that was scraped to remove the periosteum. It exhibits a minimally invasive polish that is suggestive of use with dry hide. The other two needles were fashioned from artiodactyl long bone fragments. In one case, the artiodactyl needle raw material was not identifiable. In the other case, the raw material source was the distal ulna diaphysis and epiphysis. The ulna was prepared by grooving and snapping that removed the tool blank, with deep cutmarks evident under magnification radiating from the lateral groove and snap fracture. The method used for the other artiodactyl-derived needle was unclear. Both artiodactyl needle fragments were then longitudinally scraped to further shape them. The artiodactyl indeterminate long bone needle fragment was additionally ground to its final form. The proximal half of this tool has over 50 transverse grooves, including nine prominent grooves on one aspect and two on the other aspect. Its polish signature indicates use wear from fresh or dry hides. The use wear signature on the artiodactyl ulna-derived specimen also has strong transverse striations or shallow use wear grooving on its proximal one-third and a polish that is consistent with dry hide use wear.

Fourteen complete or fragmentary perforator specimens were identified in the bone artifact analysis sample from Arenosa Shelter, with 78 per cent of them originating from Terminal Late Archaic contexts in strata 3 – 9. The other specimens came from either Late Archaic (one) or earlier Middle Archaic (two) contexts. Raw material for all of the Terminal Late Archaic tools was identifiable as from artiodactyl long bones, in two cases more specifically as the distal metatarsal diaphysis and epiphysis or a more generalized metapodial diaphysis. Blanks for these long narrow tools were prepared, either by grooving and snapping, helical fracturing, chopping, or by an unknown method, and the blanks were then further shaped by longitudinal scraping and grinding to final form with a narrow oval to virtually round distal cross section. They were apparently used for several tasks as remnant use wear is indicative of contact with dry hide, hide with attached hair, fresh hide, silica-rich plants, and wood. The intact tips of three of these specimens exhibit tip tear-out or the presence of micro-bevels. The long specimen with the micro-bevels is complete and has multiple transverse deep and broad cutmarks or grooves across its proximal one-quarter that may indicate a hafting modification. At least two other specimens appear to be broken remnants of larger tools that were refitted into the form of a perforator. The Late Archaic specimen was unique as it was a dorsal spine from a large fish that exhibited a rounded cross section and minimal additional shaping. Its use wear was consistent with contact from silica-rich plants. The two Middle Archaic specimens both were identifiable as originating from artiodactyl metapodia that were prepared in similar fashion to the later tools. Remnant use wear indicates dry hide and silica-rich plant contact.

Another Terminal Late Archaic specimen was identified as a perforator fashioned from a modified catfish spine. Modified catfish pectoral spines were manufactured into several forms of tools, including perforators, by scraping or grinding their oval cross section and tip section. In this case, the tip was ground to a rounded cross section. The remnant polish on the distal half of the tool indicates use with dry hides.

Two tools from the site's more recent contexts are similar to the antler pressure flaking tools previously described. The Historic – Late Prehistoric and Terminal Late Archaic tools exhibit cross section and tip profile characteristics that are similar to the antler tools. Each has a relatively rounded tip on a long narrowly tapered distal segment. Both tools have tips that are 2 – 3 mm in width with an approximately round cross section. The Historic – Late Prehistoric specimen has a rounded tip profile with slight crushing damage and small amount of lateral tear-out. The Terminal Late Archaic context tool has a rounded, slightly beveled tip. Tool blanks for both were prepared by an unknown method, with subsequent longitudinal scraping and grinding to final shape. Under magnification, both tips have use wear characteristics that include longitudinal scrapes and striations or bright invasive polish that is consistent with contact by siliceous stone.

Two tools used in woodworking were distinguished in the sample of bone artifacts analyzed from the site, both here termed rib tools. Both were fashioned from artiodactyl bone, in once case identifiable as a distal rib segment. One was a distal fragment from a larger Historic – Late Prehistoric tool with a widely tapered, beveled tip. While the blank for this specimen was prepared by an unknown method, it was scraped to final shape. The Terminal Late Archaic context tool blank was prepared by grooving and snapping followed by scraping to final shape. Use wear on both specimens was consistent with wood contact.

The largest group of formal implements are variants on the spatulate theme that includes an oval distal tip cross section as its central definition. Two hundred twenty seven specimens of these were identified in the analyzed sample. They included examples from each identified cultural context producing bone tools, as well as unprovenienced specimens. The most frequent tools in this group were those defined specifically as within the spatulate implement form. Within this group there were 184 complete or fragmentary tools, over 55 per cent (102 specimens) from Terminal Late Archaic context. Middle Archaic spatulates accounted for the next most frequent constituent of the spatulate form, with slightly more than 17 per cent (32 spatulate fragments) identified in the sample. Late Archaic spatulate fragment were almost as numerous as those from the previous cultural context, with slightly more than 15 percent (28 fragments). While less numerous, the 15 complete and fragmentary Historic – Late Prehistoric spatulates included one complete tool and included about 8 per cent of this form identified in the Arenosa Shelter sample. Slightly less than 4 per cent (7 spatulate fragments) were unprovenienced.

As stated previously, the 15 Historic – Late Prehistoric spatulates included one complete tool, with 14 additional fragmentary tools also present. Complete or relatively complete specimens measured 140 – 160 mm in length and 15 – 25 mm in width. About half of the Historic – Late Prehistoric spatulates had sufficient portions of the distal ends to determine tip profile characteristics. Narrow, constricted tip sections were present in 4 cases. Broad, sharply taped tip sections were present in 3 cases. Due to tip damage, tip profiles were only identifiable as rounded in 3 instances and relatively sharp in a single case.

Artiodactyls provided raw materials for 13 of the 15 specimens, two of which were identifiable as deer. Source animals for the other two Historic – Late Prehistoric spatulate fragments were identifiable only as medium to large mammal. Five artiodactyl metapodials, three artiodactyl metatarsals, a deer metatarsal and metacarpal, a medium to large mammal rib, a medium-sized mammal tibia, and four artiodactyl indeterminate long bones served as raw material for the Historic – Late Prehistoric spatulate tool blanks.

The blank preparation method for eight (53 per cent) of these specimens was not identifiable, six (40 per cent) involved grooving and snapping, and one (7 per cent) used a helically fractured fragment of butchering waste as a starting point for further modification. It should be noted here that blank preparation method is not identifiable where subsequent shaping and smoothing have removed evidence for it, such as on the distal ends of tools. The prepared blanks were shaped and smoothed by use of both longitudinal scraping and grinding in just over half (eight) of the Historic – Late Prehistoric spatulate cases, longitudinal scraping only in about 27 per cent (four) of the cases, and grinding only in about 20 per cent (three) of instances. In two cases, additional scraping and grinding was use to refit and reshape broken tools to extend their useful life.

Use wear characteristics for the Historic – Late Prehistoric spatulate specimens also varied. Due to weathering, root-etching, carnivore-ravaging, and other surface destructive forces, four of the 15 complete or fragmentary spatulates from this context did not retain identifiable remnant use wear. Ten of the remaining 11 (61 per cent of total) had been used with a variety of materials that included silica-rich plants (20 per cent), fresh hides (20 per cent), dry hides (7 per cent), hide with attached hair (7 per cent), and wood (7 per cent). One specimen (7 per cent) had wear from both silica-rich plants and dry hide.

Slightly more than 100 complete and fragmentary spatulates were identified from Terminal Late Archaic context in the Arenosa Shelter bone artifact collection sample that was analyzed during the current research. These included three complete spatulates and 99 fragments of varying portions of spatulate tools.

Complete or relatively complete specimens from Terminal Late Archaic context measured 70 – 175 mm in length and 14 – 28 mm in width. About 25 per cent of the specimens had sufficient portions of the distal end present to determine tip section characteristics or tip profiles. Narrow, constricted tip sections were present in 18 cases. Broad, sharply taped tip sections were present in three cases. Due to tip damage, tip profiles were only identifiable in 12 cases with rounded profiles found in three instances and relatively sharp in four cases. Beveling of the tip accounted for eight of the tip profiles, sometimes accompanying rounding or sharpness of the tip.

Artiodactyls provided raw materials for 100 of the 102 specimens, 29 of which were identifiable as deer. Source animals for the other two Terminal Late Archaic spatulate fragments were identifiable as freshwater drum in one case or mammal in another case, providing a dorsal spine and indeterminate long bone, respectively. Raw material for Terminal Late Archaic spatulate tool blanks was provided by long bone from undifferentiated artiodactyls that included 26 metapodials, 17 metatarsals, four metacarpals, two tibiae, one humerus, one ulna, and 20 indeterminate long bones. Deer bone used as raw materials included 25 metatarsals, two metacarpals, and two metapodials.

The blank preparation method for 37 (36 per cent) of these specimens was not identifiable, 55 (54 per cent) involved grooving and snapping, five (5 per cent) chopping, and five (5 per cent) used a helically fractured fragment of butchering waste as a starting point for further modification. It should be noted here that blank preparation method is not identifiable where subsequent shaping and smoothing have removed evidence for it, such as on the distal ends of tools. The prepared blanks were shaped and smoothed by use of both longitudinal scraping and grinding in 25 per cent (26) of the Terminal Late Archaic spatulate cases, longitudinal scraping only in about 60 per cent (61) of the cases, and grinding only in about 13 per cent (13) of instances. Refitting appears to have been employed to reshape tools to extend their use in five cases.

Use wear characteristics for the Terminal Late Archaic spatulate specimens also varied. Due to weathering, root-etching, carnivore-ravaging, and other surface destructive forces, three of the 102 complete or fragmentary spatulates from this context did not retain identifiable remnant use wear. The remaining 99 (97 per cent of total) had been used with a variety of materials that included silica-rich plants (61 per cent of total), fresh hides (4 per cent of total), dry hides (5 per cent of total), hide with attached hair (1 per cent of total), and wood (24.5 per cent). At least five specimens had multiple use wear signatures, indicating multiple uses or a complex history of use.

The Late Archaic spatulate inventory analyzed in this study included 28 fragmentary specimens from a context within strata 10 and 11. The most complete specimens from Late Archaic context measured 97 – 164 mm in length and 19 – 25 mm in width. Only six of the specimens had sufficient portions of the distal end present to determine tip section characteristics or tip profiles. Narrow, constricted tip sections were present in four cases. Medium width tip sections were present in a single case. A broad, sharply taped tip section was present in one case. Due to damage or absence, profiles of the extreme tip were only identifiable in four cases with rounded profiles found in two instances and relatively sharp in one. No beveling of the tip sections was noted for Late Archaic specimens.

Artiodactyls provided raw materials for all of the 28 specimens, seven of which were identifiable as deer. Raw material for Late Archaic spatulate tool blanks was provided by long bone from undifferentiated artiodactyls that included nine metapodials, four metatarsals, one tibia, and seven indeterminate long bones. Deer bone used as raw materials included four metatarsals and three metacarpals.

The blank preparation method for 15 (53.6 per cent) of these specimens was not identifiable, 12 (42.9 per cent) involved grooving and snapping, and one (3.5 per cent) used a helically fractured fragment of butchering waste as a starting point for further modification. The prepared Late Archaic spatulate blanks were shaped and smoothed by use of both longitudinal scraping and grinding in 68 per cent (19) of the cases, longitudinal scraping only in about 14 per cent (four) of the cases, and grinding only in about 3.6 per cent (one) of instances. Refitting appears to have been employed to reshape tools to extend their use in three cases.

Use wear characteristics for the Late Archaic spatulate specimens were variable. Due to weathering, root-etching, carnivore-ravaging, and other surface destructive forces, only one of the 28 complete or fragmentary spatulates from this context did not retain identifiable remnant use wear. The remaining 27 (96.4 per cent of total) had been used with a variety of materials that included silica-rich plants (42.8 per cent of total), fresh hides (3.6 per cent of total), dry hides (3.6 per cent of total), and wood (17.8 per cent). At least one specimen had multiple use wear signatures, indicating multiple uses or a complex history of use. This refitted spatulate fragment was used with both silica-rich plant material and dry hides.

Middle Archaic spatulates included in the current Arenosa Shelter bone artifact analysis included 29 fragmentary specimens from between stratum 12 and stratum 30. Middle Archaic spatulate were considerably more fragmented than those from more recent contexts, with only three of the spatulates exceeding 80 mm in length. The longest of these was 96 mm in length and was only a portion of a longer tool. A relatively complete shorter tool was 40 mm in length. Due to the inclusion of epiphyseal portions of the raw material bones in some of finished tools, maximum tool widths approaching 35 mm were noted although most fragments were considerable narrower. Only two of the specimens had sufficient portions of the distal end present to determine tip section characteristics or tip profiles. A narrow, constricted tip section was present in one case. One beveled tip section was noted for Middle Archaic specimens.

Artiodactyls provided raw materials for all 29 Middle Archaic specimens, seven of which were identifiable as deer. Raw material for these spatulate tool blanks was provided by long bone from undifferentiated artiodactyls that included 13 metapodials, seven metatarsals, one tibia, and one indeterminate long bones. Deer bone used as raw materials included four metacarpals and three metatarsals.

The blank preparation method for 12 (41 per cent) of these Middle Archaic specimens was not identifiable, 15 (52 per cent) involved grooving and snapping, one (3.5 per cent) used chopping, and one (3.5 per cent) used a helically fractured fragment of butchering waste as a starting point for further modification. The prepared Middle Archaic spatulate blanks were shaped and smoothed by use of both longitudinal scraping and grinding in 62 per cent (18) of the cases, longitudinal scraping only in about 28 per cent (eight) of the cases, and grinding only in about 10 per cent (three) of instances. Refitting appears to have been employed to reshape a single tool to extend its use.

While weathering, root-etching, carnivore-ravaging, and other destructive forces acted to fragment spatulates that were deposited in cultural deposits within Arenosa Shelter's Middle Archaic context, all 29 fragmentary spatulates from this context in the sample retained identifiable remnant use wear. Use wear characteristics for the Middle Archaic spatulate specimens were variable. The majority had been used with silica-rich plants (72 per cent), although the tools were also used on other materials that included sinew (3.4 per cent), and wood (24 per cent) made up the rest. No specimen had multiple use wear signatures that might indicate multiple uses or a complex history of use.

Unprovenienced fragmentary spatulates accounted for 7 of the specimens in the current analysis. Five of these were fashioned from the remains of undifferentiated artiodactyls, one was from a deer, and the last was from an unidentified medium to large mammal. Three of the artiodactyl-derived specimens were relatively large, between 65 and 80 mm in length. Four of the deer or artiodactyl-based spatulate fragments were in excess of 14 mm in width. Only one of the specimens had sufficient portions of the distal end present to determine tip section characteristics or tip profiles. A narrow, constricted tip section with bevel was present in the case of the unidentified medium to large mammal.

The blank preparation method for three (43 per cent) of these unprovenienced spatulate specimens was not identifiable, three (43 per cent) involved grooving and snapping, and one (14 per cent) used a helically fractured fragment of butchering waste as a starting point for further modification. The unprovenienced prepared spatulate blanks were shaped and smoothed by use of both longitudinal scraping and grinding in 72 per cent (five) of the cases and grinding only in about 14 per cent (one) of instances. A single case (14 per cent) was too weathered and carnivore ravage to determine shaping or smoothing measures that may have been used in its manufacture. Signs of refitting to extend their use were not recognized in any of these unprovenienced fragmentary implements.

All unprovenienced fragmentary spatulates in the sample retained identifiable remnant use wear, although one specimen had only faint traces that could not be identified. Use wear characteristics for the unprovenienced spatulate specimens were variable. The majority (four specimens, 57 per cent) had been used with, although three

(43 per cent0 of the tools were also used on silica-rich plants. No specimen had multiple use wear signatures that might indicate multiple uses or a complex history of use.

An additional form of spatulate found exclusively in Terminal Late Archaic context is made from catfish pectoral spines that had modification of the distal tips, and in some cases, more extensive modifications to the diaphysis of the element. Six specimens of catfish spine spatulates were identified in the Arenosa Shelter bone artifact sample analyzed in the current research. Several of the specimens contain the same transverse deep cutmarks at their base that was noted in Chapter 5 as severing the muscles that control the friction-locking mechanism which holds the spines rigidly erect when the fish is threatened. The Arenosa Shelter residents apparently disarmed the catfish's defenses during catch or butchering and the resulting cutmarks remaining on later tools. Three of the catfish spine spatulates have sharp tips and two have the tips absent. Blank smoothing and shaping was done by longitudinal scraping and/or grinding to flatten the cross-section, remove the teeth along the spine's edges, and to modify the tip profile. Remnant use wear is present on five of the specimens that show use with silica-rich plant materials (three specimens), fresh hides (one specimen), and dry hides (one specimen).

Variants of more typical spatulates were also included in the Arenosa Shelter sample analysis. The first of these was the spatulate/bodkin, a possible Terminal Late Archaic tool form that was fashioned from appendicular skeletal elements of deer or pronghorn-sized artiodactyls. Five spatulate/bodkin specimens were recovered from Terminal Late Archaic contexts at Arenosa Shelter and studied during the current research. Another three unprovenienced specimens were also recovered during the Arenosa Shelter excavations and analyzed as part of this study. Except for one first phalange, each of these was manufactured from a distal metacarpal. Source animal for six of these artiodactyl-derived tools were recognizable as deer. Three of the spatulate/bodkin fragments were large enough to determine that the complete tools would have been in excess of 120 mm long and about 20 mm wide. Blank preparation was by grooving and snapping (three specimens), or by unknown methods that may have included either chopping or dynamic fracturing (five specimens). Shaping and smoothing evidence points to scraping and grinding being used, with heavy modification of the area around the condyles by grinding into the underlying cancellous bone. In at least one instance, the medial groove between the condyles was hollowed out. Remnant use wear is suggestive of uses with silica-rich plant materials (six specimens), dry hide (one specimen), and hide with attached hair (one specimen).

A single spatulate/creaser from Terminal Late Archaic context was fashioned, similar to bodkins and spatulate/bodkins, from the metacarpal of a deer-sized artiodactyl. This long narrow tool had a narrow, tapered, and beveled tip section with a rounded profile. The cross section of the tip section is a narrow oval. Blank preparation was by chopping, using longitudinal scraping and grinding to with smooth and shape the tool to its final form. The wear signature is consistent with use on fresh hides.

Spatulate/perforators were also found in Terminal Late Archaic context. Two of them originated from artiodactyl metapodia, but the third was fashioned from a catfish pectoral spine. These long narrow tools had very constricted tip sections with an oval cross section and rounded profile. The catfish specimen had several ground micro-bevels evident under magnification, but was otherwise minimally modified. The artiodactyl metapodial-based spatulate/perforator blanks were prepared using unknown methods, then ground or scraped and ground to final form. Use wear signature for all three Terminal Late Archaic spatulate/perforators was consistent with dry hide contact.

Five fragmentary narrow spatulates were documented within the analysis sample, the majority from Terminal Late Archaic context in strata 3 – 9. One of the specimens came from Middle Archaic context, with the final specimen coming from Historic – Late Prehistoric context above stratum 3. Except for one Terminal Late Archaic specimen for which the source animal may only be identified as a medium to large size mammal, all of the narrow spatulates were manufactured from deer or pronghorn-sized artiodactyls. One of the artiodactyls provided a metatarsal as raw material; the remainder of the artiodactyl skeletal material was identifiable only to metapodia. The raw material from the unidentified mammal was identified only as indeterminate long bone. The largest of these narrow spatulate fragments was almost complete and was 85 mm in length. Most were between 35 and 50 mm in length, with a width less than 14 mm. Blank preparation was by grooving and snapping or by unknown methods, with subsequent smoothing to final shape by scraping or scraping and grinding. Use wear is variable with three of the five specimens having a signature indicating contact with silica-rich plants, one with wood, and one with dry hide.

A total of nine spatulate fragments decorated by incising of parallel lines or cross-hatching were documented during this analysis. Similar to narrow spatulates, incised spatulates were most numerous in Terminal Late Archaic context (seven specimens), but were also found in Middle Archaic and Historic – Late Prehistoric context. All seven incised spatulates were identifiable as being manufactured from deer-sized artiodactyl long bones, most typically metapodia. One of these was a deer metatarsal and two artiodactyl metatarsals were also recognized as providing raw materials for incised spatulates. Blank preparation was by grooving and snapping in all but two cases where the method used was unknown. Smoothing and shaping was applied prior to incising of the decoration on the tools and was done by longitudinal scraping and grinding in four cases, only longitudinal scraping in two cases, and grinding in one case. Tools were decorated with multiple incised transverse parallel lines, cross hatching, or chevrons, all typically placed along either a lateral edge or across the proximal end of the tool. Polishing following incising is indicated in at least two of the cases that have smooth edges to the incised lines, with a wear signature suggestive of wet or fresh hide that is separate from the overall use wear pattern for the tool fragment. Use wear for these seven specimens is predominately from silica-rich plants (six specimens), although wood (two specimens) and dry hides (one specimen) were also indicated. One specimen was too weathered to have remaining identifiable use wear.

Five ulna spatulates were recovered from Terminal Late Archaic context and included in the current analysis. The source animal for these long tools was typically a deer-sized artiodactyl. Four of these tool fragments were recognizable as deer. The tool fragments included the proximal epiphysis of the ulna, including the lunar notch and articulation, and had a distal edge 100 – 125 mm down the diaphysis of the element. Blank preparation was by grooving and snapping, chopping, or unknown methods, with further shaping by grooving to produce possible hafting modification, and scraping and/or grinding. Use wear signatures observable in four of the cases indicated use with silica-rich plants, dry hides, or wood.

Distally notched spatulates were a distinctly Middle Archaic occurrence in the analysis sample. Three of these unique spatulate forms were identified. Two of them were fashioned from deer-sized artiodactyl metacarpals and the third was manufactured from a medium to large mammal humerus. Each of the specimens had a tip section with a V-shaped bifurcation that has been scraped or cut into the wide distal end. The bifurcation is up to 8 mm deep and separates two tips that are up to 5 mm wide and 3 mm thick. The tips have been shaped by scraping and are blunt and battered on one of the specimens. Helically fractured blanks were prepared for two of the specimens, while the method for the third could not be determined. Use wear is different for each of the specimens. The short, blunt-tipped artiodactyl specimen has wear from wood contact. The longer, more sharply tipped artiodactyl specimen has wear from contact with sinew and the unidentified mammal specimen has wear from hide with attached hair.

A single item from Middle Archaic context was identified that was similar in several ways to the artiodactyl-derived distally notched spatulates previously described. It was a lateral fragment from the proximal end of a longitudinally split tool form that had been prepared by surface scraping and then had a deep, wide bifurcation incised or scraped along its mid-point. A remnant of a second 3.5 mm long tip section was present, across the bifurcation from the main portion of the fragment. The proximal end exhibited a transverse groove and snap fracture. The overall profile of this tool fragment was roughly in a J-shape. The burned condition of the fragment limited an accurate determination of its use wear. The overall layout also suggests a preform for a bone fish hook as described in Harrell (1983).

Also from Middle Archaic context came a specimen of softshell turtle plastron that has faint incised cross-hatching. The fragment has a bright, slightly invasive polish present on its surfaces and numerous smooth-edged striations oblique or paralleling one axis of the cross-hatching. The use wear is consistent with contact from fresh hides.

Two relatively small tools exhibit a stepped triangular profile that is otherwise unknown in the analyzed sample and were termed wedges. One of these came from Terminal Late Archaic context and the other was unprovenienced. Both of these specimens were fashioned from artiodactyl appendicular skeletal material, although the raw material for the Terminal Late Archaic specimen could not be identified beyond indeterminate long bone. The raw material for the unprovenienced specimen was identifiable as the proximal diaphysis of a deer 3rd phalange. Both of these short, wide, sharply tapering tools had three shallow transverse stepped grooves cut and ground across their surfaces. The tip of the unprovenienced specimen exhibited slightly tear-out. The use wear present on each specimen is indicative of contact by wood, with a non-invasive to slightly invasive polish and rounding of features, with longitudinal striations evident on the Terminal Late Archaic specimen.

The final tool form encountered in the Arenosa Shelter bone artifact analysis sample was also apparently used in conjunction with processing of wood. A single unprovenienced specimen derived from an artiodactyl metatarsal diaphysis was manufactured from spatulate manufacturing debitage. This tool had a moderately narrow (7 mm width), beveled tip that had several facets ground across its face. Although the tip is broken, the facets and limited adjacent areas retain discoloration and polish on high points, with limited rounding of the facet edges. Also present are grouped narrow, smooth-edged, oblique striations angling back from the discolored areas at the tip and the thicker lateral edge. This use wear is consistent with wood contact.

An unprovenienced spatulate manufacturing blank failure fashioned from a heavily deer tibia diaphysis was scraped to remove the periosteum prior to cutting of a transverse groove and snap the distal epiphysis. A helical fracture is also present on the other end of this specimen. This item has no evidence of subsequent shaping or wear from use.

Nine examples of spatulate manufacturing debitage were identified in the analysis sample. All were fashioned from artiodactyl long bone, with one of them being identifiable as a deer metatarsal that included the proximal epiphysis. Six of the specimens were from Terminal Late Archaic strata and included diaphyses segments from four metatarsals, a tibia, and a humerus. A single Late Archaic specimen was identifiable as an undifferentiated artiodactyl metapodial, as was one of two Middle Archaic specimens. The final Middle Archaic specimen was the deer metatarsal mentioned previously. Processing of the elements to remove tool blanks was similar for most specimens, with grooving and snapping being used to detach portions of the element either longitudinally or transversely. In the case of the Middle Archaic deer metatarsal, grooving and snapping was used to detach the blank from the epiphysis following helical fracturing. Longitudinal scraping was used to remove the periosteum or being initial scraping for the Late Archaic specimen and two of the Terminal Late Archaic specimens, each a metapodial. One of the specimens from Terminal Late Archaic context shows wear from contact with wood, possibly during the manufacturing process.

A single example interpreted as debitage from refitting of a spatulate was recognized that originated from within Terminal Late Archaic context. This metapodial fragment had a distal transverse groove and snap fracture and evidence of longitudinal scraping. The remnant use wear indicates contact with dry hide.

Three spatulate preforms or early stage blanks from Terminal Late Archaic context were identified in the collection sample. All were from artiodactyls, one recognizably form a deer metacarpal. One includes a segment from the distal half of a preform that has been scraped to shape, but not yet ground to its final profile. Another is from the proximal half of a preform that has been prepared by grooving and snapping to detach the blank and longitudinally scraped to shape, but not yet ground to its final form. The third specimen has lateral edges that are have begun to be smoothed to its final form following scraping.

A similar fragment of a preform from Terminal Late Archaic context was identified as a separate tool preform. This deer metatarsal fragment is helically fractured and carnivore ravaged but was identified as an early stage spatulate or perforator preform.

Additional more detailed data concerning specimen condition, physical measurement, cultural context, taxon, anatomical element, manufacturing, and use wear characteristic for individual specimens are presented in Table 6.9.

III. INTERPRETATION

Chapter 7: Discussion

OVERVIEW OF SUBSISTENCE EVIDENCE AT ARENOSA SHELTER

Excellent preservation of perishable materials in Lower Pecos region archaeological sites allows researchers to put the reliance of prehistoric inhabitants on faunal resources into perspective with their reliance on floral resources. The results of the current research using collections obtained during excavations at Arenosa Shelter in the mid- to late 1960s have clarified issues concerning prehistoric subsistence practices. This is especially true for those relating to procurement and processing of terrestrial and aquatic fauna in the Lower Pecos cultural region. The relationship of fauna-centered subsistence practices of prehistoric inhabitants to their bone modification practices is reflected in how faunal residues were incorporated into the technological base as raw materials for ornaments or implements. While not necessarily issuing from the other process, a more complete understanding of the Lower Pecos cultural region's bone technology is enriched by a thorough understanding of the results of prehistoric subsistence behaviors practiced by the region's inhabitants.

Arenosa Shelter's depositional history, its effects on the site's taphonomic history and subsequently, its effects on the resulting bone artifact collection analyzed as part of the current research, limit the full magnitude of this increased understanding to the past 4,500 years. Thus, any understanding about the regional interrelationship between subsistence and technology behaviors that is based on the Arenosa Shelter collections is limited to the Middle Archaic or later cultural stages. However, some insight into subsistence behaviors and the region's faunal makeup during the Early Archaic and Paleoindian stages is possible using the Arenosa Shelter faunal collection.

Chronological Units

For analytical purposes, the current research separated the Lower Pecos's defined cultural chronology into six periods that are slightly different than typically used in the region. Part of the author's reasoning behind such modifications to how culture history is considered is that the site's depositional history, the excavation techniques used, and the recovery strategies employed by the site's excavators do not allow deposits from Late Prehistoric and Historic stages at Arenosa Shelter to be differentiated. Another part of the reasoning for presenting an atypical view of culture history is that the portion of the collection from the earliest Late Archaic context may be securely differentiated from later portions. Doing so allows a comparison between subsets of data that allow tools and ornaments from the earlier Cibola period, with its emphasis on big game and cultural similarities to the Southern Plains, to be differentiated from the remainder of the Late Archaic portion of the collection. Due to the predominance of Late Archaic artifacts in the bone artifact collection, the ability to differentiate between portions of this period is beneficial to interpreting the results.

Table 7.1 is presented to reiterate the current minor modifications to defined regional cultural stages used in the current research. Approximate dates used in the table are in the format originally presented by the site's excavator using uncorrected radiocarbon years before present.

The uppermost of the Paleoindian strata in Arenosa Shelter contains the single radiocarbon assay from the site's deepest strata. This assay yielded a date of 9,550 radiocarbon years before present. Due to the paucity of charcoal or other datable material found in lower strata, the site's excavator was unable to firmly date the late Pleistocene –

early Holocene faunal remains in strata 40 – 42 at the time that the original radiocarbon dates were done.

To review data introduced in Chapter 5, the bulk of analyzed subsistence remains was in cultural contexts that dated to the Late Archaic or later. The highest NISP frequency in the sample came from Terminal Late Archaic context, a NISP:MNI/MNE ratio of 6.03. Comparing NISP:MNI/MNE ratios between Historic – Late Prehistoric and Late Archaic contexts yields values of 2.19:1 and 3.19:1. This difference is interpreted as an indication of a considerably higher degree of fragmentation among Terminal Late Archaic materials that had a much higher NISP frequency, but lower MNI/MNE frequency in relation to the NISP. Late Prehistoric – Historic remains were less fragmented than other late context faunal remains from Arenosa Shelter.

While not totally absent from earlier Archaic contexts, subsistence remains were much less frequent. They exhibited a 60 per cent decrease in total abundance between the earlier of the Late Archaic time periods and the Middle Archaic. A much more drastic reduction in frequency occurred between the Middle Archaic and preceding Early Archaic. Extremely disturbed Early Archaic cultural remains from Arenosa Shelter provided minimal evidence of either faunal remains or subsistence behaviors of the region's human inhabitants. They were contained in strata that evidenced major flood perturbation. Due to favorable preservation conditions provided by the "mother rock" against the effects of subsequent high energy flooding, faunal remains from Paleoindian context were more frequent than those from the subsequent Middle Archaic and Early Archaic.

Paleoindian faunal remains were more than 15 times more abundant than Early Archaic remains and as abundant as those from the Middle Archaic. Composite NISP:MNI/MNE ratios for Middle Archaic, Early Archaic, and Paleoindian contexts are

3.19, 2.17, and 6.2, respectively. A comparison of these ratios shows that the Middle Archaic and Early Archaic faunal materials are less fragmented than faunal remains from the Paleoindian period. They are also less fragmented than remains from Terminal Late Archaic contexts.

Working with this concept and data about relative abundance of vertebrate body size classes presented in Chapter 5, the degree of element fragmentation present in cultural contexts may be compared. Table 7.2 presents NISP:MNI/MNE ratios aggregated for each vertebrate body size class by cultural context.

Low values for ratios in Table 7.2 are consistent with either a low frequency or a direct correspondence between NISP and MNI/MNE, such as would occur with single prey animals contained in human coprolites or predator scat deposited in dry cave sites. Similarly, the higher values for the NISP:MNI/MNE ratios for undetermined fish and mammals in Terminal Late Archaic contexts are strongly affected by the low MNI/MNE frequency for these particular taxonomic groupings.

Mammals were the most frequent faunal residues in all cultural contexts. Fish also constituted a sizable constituent of the faunal remains. During the current analysis, fragmentation of specimens in the collection was noted as originating from cultural behavior-induced changes or carnivore ravaging that occurred before deposition and diagenetic changes that occurred in skeletal elements after deposition. Due to the structure of bone as a matrix of longitudinal fibers in a collagen matrix, it reacts negatively to physical stresses after changes that reduce the internal moisture content of the collagen matrix. Relatively greater intensity of diagenetic changes or cultural processing both impacted bone deposited in the site by fragmenting it and rendered this sizable portion unidentifiable. Highly fragmented mammal and fish remains unidentifiable to taxa lower than vertebrate class were especially common in the

Terminal Late Archaic period. Remains representing unidentifiable mammals or fish constituted a significant part of the total faunal remains and almost 20 per cent of the NISP frequency for the Terminal Late Archaic period.

Subsistence evidence for the Paleoindian period is limited. While large mammal remains identified as *Bison antiquus* or *Equus* sp. are relatively numerous, evidence for cultural modification of them is limited, at least partly due to the deteriorated physical condition of the fragments themselves and carnivore ravaging of the fragments' surfaces. Also, the less sophisticated recovery strategy used in the stratum 42 Paleoindian deposits at Arenosa Shelter did not allow for reconstruction of bone fragment scatters, such as those in basal strata at Bonfire Shelter (Bement 1986). A single bison radius from stratum 42 exhibits a transverse cut mark that would sever the brachialis muscle insertion. Three of the bone fragments from this same stratum show evidence of dynamic fracturing that could potentially be due to controlled bone breakage similar to that documented by Bement (1986) in the Late Pleistocene basal deposits at Bonfire Shelter in bone fragments surrounding an anvil.

Other potential evidence for Paleoindian subsistence practices includes the carcass of a young *Bison antiquus* bull from Feature 18 in stratum 40. Interpretation of these remains is again limited by their poor physical condition and incomplete recovery of documented remains from this very constrained excavation under the "mother rock". None of the remains examined from Feature 18 has any evidence of cutmarks and none had evident helical fractures that could be related to controlled bone breakage.

The earliest evidence for possible subsistence practices in the site comes from the limited faunal material remaining in the highly disturbed deposits in Early Archaic context. Although originating from the redeposited spally lag facies in stratum 32, north of N200, a single burned deer metatarsal fragment was recovered that may provide evidence of prehistoric cultural behavior although it did not contain cut marks associated with subsistence activities.

Subsistence practices in the Middle Archaic are more solidly documented due both to the less disturbed, primary context that they originate within and the higher frequency of Middle Archaic vertebrate remains that reconstruction of the practices are based upon. Rodents clearly enter the subsistence picture during this period, with the gray squirrel, ground squirrel, gopher, wood rat, and beaver being hunted or trapped using snares or nets evident in the archeological record (Shafer 1986:72 – 78). Medium to large mammal remains from this context are burned or exhibit helical fractures. The remains of a coyote or domestic dog were broken using dynamic fracturing, possibly to obtain marrow or to use in tool making, and a small fox was damaged by heat, potentially from roasting. Fish included a wide variety of gar, catfish, large suckers, and drum caught from the rivers using nets, toxicants, or other means. They were filleted and cooked. Dabbling ducks were also hunted along the rivers, as were soft-shelled turtles that could be carefully picked up. In the brushy main canyons and other areas with suitable cover, quail were taken, possibly by throwing stick, rocks, or thrown nets. Both deer and antelope were included in the artiodactyl herbivores hunted in the river canyons and surrounding terrain. Middle Archaic remains from deer or pronghorn-sized ruminants contain butchering evidence of carcass dismemberment and defleshing. They also contain evidence for heavy fragmentation of the resulting bone for marrow removal.

By the early part of the Late Archaic, considerably more subsistence evidence accumulated. Rodents continue to occur as subsistence residues, but beginning in this period, remains of small and large rabbits begin to appear prominently in the archeological record of Arenosa Shelter, allowing their role in prehistoric subsistence practices to be determined. Rabbits were driven into nets, clubbed with throwing sticks, or snared. Skinning and butchering of jackrabbits is documented from placement of cutmarks on remains in this context. Butchering evidence of these larger rabbits is such that it indicates skinning prior to disarticulation and dismemberment of the appendages, then defleshing of the dismembered carcass. The evidence for cottontails is somewhat similar, although skinning behavior may not include skinning the head out and disarticulation of the shoulder and hip joints by cutting was not practiced on these smaller rabbits. An alternative method used with the smaller rabbits appears to have been severing the muscle masses on the proximal upper long bones, with subsequent breaking of the long bone diaphysis itself. Burning patterns on long bone elements indicates damage with the meat still on the bone partially insulating elements and supports an interpretation of secondary butchering following completion of cooking.

Turtles were collected and prepared for food during the Late Archaic, as indicated by dismemberment evidence on the long bones. Both soft-shelled and snapping turtles were hunted or trapped. The animals may have been roasted in the shell, as burned softshell turtle carapace fragments also occur in this context.

Fish from the region's rivers continued to be netted, poisoned, or obtained through other means including noodling or other physical methods as part of the subsistence behavior used in the Late Archaic, as indicated by heat alteration and butchering damage. Catfish could be caught by noodling, speared in shallow water, or by use of weirs. Prior to butchering, the musculature controlling their defensive pectoral spines was severed or the spines themselves were snapped off. Several larger species of catfish included those with deep water habitat preferences and habits required use of nets and toxicants. The butchering of these and other fish by the Lower Pecos prehistoric inhabitants during the early part of the Late Archaic continued the Middle Archaic practice of filleting. Other medium to larger fish species included freshwater drum and suckers, both indicating a wide variety of habitats being tapped by the subsistence behaviors, including the deeper pools of the rivers. Many of these species have oily flesh that is higher in calorie content (Lord (1977).

During the early part of the Late Archaic, geese and diving ducks were trapped, hunted, or netted near the deeper riverine pools as they migrated through the region in fall or spring. Gulls were also taken when present, possibly with throwing sticks or thrown rocks. Roadrunners, quail, small hawks such as Mississippi kites and sparrow hawks, and larger hawks were taken for food or other uses using thrown nets, snares, or other means.

Complementing rabbits, artiodactyls also provided a major part of the animal-based subsistence during the early part of the Late Archaic, with at least three forms contributing to the larder, tool kit, and economy. Mule deer, undifferentiated deer, and non-diagnostic remains of artiodactyls that could not be distinguished between deer and antelope were identified within this context. The skins were carefully removed, and then the carcasses were disarticulated, largely dismembered, and defleshed. Burning of bone fragments in the collection indicates housekeeping in the shelter to dispose of defleshed remains and possible roasting. The long bones of artiodactyls were fractured to remove marrow or for bone grease production, as was splitting of the bones and further modifications done as part of incorporating this material into the tool-making practices.

The Terminal Late Archaic saw a continuation of previous emphases on using a wide variety of animal sources of food, bone, and skins, but with a possible broadening to an emphasis on skins from medium-sized mammalian carnivores. Specialized techniques were used to take complete skins from medium sized carnivores. Turkeys and doves were present in the brushy canyons and served as food and other uses. Hawks continued to be hunted, snared, or netted for multiple purposes. The riffles and pools of the rivers region's canyons continued to provide sustenance. Hunters or gatherers collected soft-shelled and pond slider turtles; trapped, hunted, or netted ducks and geese; caught shovelnose sturgeon, large gar, several species of small to very large catfish, carpsuckers, suckers and buffalo fish, white bass, and temperate bass using nets, weirs, toxicants, and more direct means such as noodling. Beavers and muskrats were also trapped from these well-watered zones. Smaller game, such as rock squirrels, were hunted or trapped on the rocky slopes overlooking the canyons and on the canyon walls themselves. Cotton rats and woodrats were also clubbed, snared or other trapped, or netted. Rabbits also continued to be netted, trapped, and hunted with throwing sticks in the canyons and surrounding semi-arid uplands. Deer and antelope again were hunted by Lower Pecos hunters in the canyons and uplands, adding additional protein and fats to fare used to support the prehistoric inhabitants of the canyons. Limited evidence from Arenosa Shelter also supports possible opportunistic hunting of an occasional bison in the canyons and surrounding upland grassland savannahs.

During the Historic – Late Prehistoric period, limited evidence is provided for incorporation of European domestic animals into the local subsistence economy. These animals became available prior to the mid-eighteenth century to the mobile groups of Apache and Comanche tribes documented by Spanish civil and ecclesiastical authorities (Kenmotsu and Wade 2002:26-32, 65-68; Weddle 1968:325). Spanish military expeditions passed nearby or through the region beginning as early as the 1670s. Native American raiding of Spanish colonial ranches in Texas and across the Rio Grande in Mexico occurred early in the eighteenth century. Direct Spanish *entradas* into the region and Native American raiding or acquisition of Spanish stock both made domestic sheep, goats, and possibly cattle, available on a sporadic basis to the canyon residents in the Lower Pecos region. During the mid-1800s, more intensive ranching by Anglo-

Americans settling in the Lower Pecos region introduced these animals to the canyon lands on a regular basis.

Specimens identified from stratum 2 included a large bovid molar fragment that could not be differentiated between cow and bison, one metacarpal fragment verified to be domestic sheep, and 11 fragments that could not be differentiated between domestic sheep and goat. Procurement of indigenous artiodactyls also continued, with pronghorns, deer, and the sparse bison that inhabited the uplands hunted. Rabbits continue their significance to the nutrition and industry of the local inhabitants. The importance of fish and other aquatic species continues, according to patterns established much earlier in the region's prehistory.

Diachronic Changes

Major regional climate changes, the resulting episodic high-energy floods, and evolution or extirpation of species themselves has altered the landscape of the Lower Pecos region since the end of the Pleistocene. Changes in plants and animals present in the canyons and surrounding uplands of the Lower Pecos have followed the regional trend as the terrestrial and aquatic communities adapted to hotter, drier conditions. Many life forms present at the end of the Pleistocene either became extinct, were regionally extirpated, or evolved to smaller size that were sometimes different enough to be classified new species or subspecies. This was true both for the large herbivores and carnivores that preyed on them and also for smaller species, such as white-tailed deer (McDonald 1981:250; Jerry Cooke, May, 2004:personal communication). The life forms present in the region have also adapted to more localized cataclysmic habitat change phenomena following destructive floods and other major runoff events that removed large trees in the river floodplains and significantly altered long-standing regimes of riverine riffles and pools.

Adjustments by the prehistoric inhabitants in their subsistence economy through time are obvious as they involve changes in targeted habitat niches or evolutionary changes in target species themselves. A discussion of such changes documented by the current research follows.

Species Evolution and Replacement

Species present in the region during the Pleistocene included a large, long-horned form of bison, *Bison antiquus,* and a large subspecies of raccoon, *Procyon lotor simus*. Both of these were replaced in the region over time by related species or subspecies, although the timing of replacement was significantly different for each. The long-horned bison was replaced on the Southern Plains during the early Holocene, possibly evolving into the modern species of *Bison bison*. Paleozoologists and vertebrate paleontologists do not agree about the taxonomy and genetic relationship of late Pleistocene bison, the possible relationship between species or subspecies of bison in the early Holocene, and the ensuing evolutionary history of modern bison (Frison 1984; Frison, *et al.* 1976; Lewis 2003; McDonald 1981; Skinner and Kaisen 1947; Wilson 1974, 1975; and Wyckoff and Dalquest 1997). *Bison antiquus* does not occur in deposits more recent than the Early Archaic here or elsewhere in the region, including Bonfire Shelter. By the beginning of the Middle Archaic, modern bison were being hunted either opportunistically in small cow-calf herds such as those that provided an occasional kill for inhabitants at Arenosa Shelter or in the very large herds that occasionally entered the region from the Central Plains, as Bone Bed 3 at Bonfire Shelter documents (Dibble and Lorrain 1968; Johnson 1987:Table 8.2).

The large subspecies of raccoon, *Procyon lotor simus*, was present in the region during the Pleistocene and through much of the Holocene, occurring elsewhere in the central and western portions of Texas (e.g. Wunderlich Cave, Reference Specimen

Number TMM-VP-40451-100) and in late Pleistocene deposits at the Washington Beach locality in the northern Mexican state of Tamaulipas (Reference Specimen Number TMM-VP-41378-1) (E. Lundelius, October, 1997:personal communication; Wright and Lundelius 1963). Its occurrence at Arenosa Shelter as late as 2,000 years ago (stratum 5) is in line with its extirpation from the Edwards Plateau and withdrawal to the north and west into its current range. The replacement by a more gracile subspecies in this portion of Texas occurred only within the past 1,000 years (Wright and Lundelius 1963).

The members of the cervid family remaining in the Lower Pecos region following the Pleistocene included both the mule deer and the white-tailed deer. The Amistad area has served as a zone of gradation between the mule deer-dominated Trans-Pecos region to the west and the whitetail deer-dominated hill country of the Edwards Plateau to the east for thousands of years (Jerry Cooke, May, 2004:personal communication). In this zone, the two species are known to hybridize, producing offspring that blend the antler, body size, and developmental characteristics of both. Genetically, the two species in this region are now more similar than to each other than they are to more pure members of either species (Ballinger, *et al.* 1992; Derr, *et al.* 1991). A known result of Holocene evolution in the region's cervid populations has been a gradual reduction in overall body size through time, including antlers.

Habitat Niche Use

Use of specific habitat niches by prehistoric Lower Pecos inhabitants to procure targeted prey species may be demonstrated by examining the habitat preferences of species represented in the faunal sample from Arenosa Shelter. These species occupied a variety of aquatic and terrestrial habitats that extended from the depths of the river canyons to the heights of the upland plains beyond. Hunters and gatherers tapping these sources of food understood a broad range of plant and animal communities and the constituents that comprised their habitat niches.

In the river canyons, deep-water pools were present episodically between riffles along the rivers between high-energy flood events. The pools met the habitat requirements for migrating diving ducks, such as the canvasback, scaup, or redhead that prefer water depths of 20 – 30 feet. The deep pools also provided suitable habitats for very large, mature members of the blue and flathead catfish species. The largest blue catfish are actively predacious and seek out other smaller fish, including their own species (Heavey 2004; Lundberg 1970). Other large fish, such as the shovelnose sturgeon and large gar, were present in these relatively permanent features along the rivers. The gar species present may have included the alligator gar, although it is not found in this portion of the Rio Grande drainage now. Shallower water would have harbored smaller catfish, the suckers, and what modern inhabitants of the region consider to be gamefish, white bass, temperate bass, and drum. The aquatic turtles used by the regions inhabitants would also have occupied this niche, as would dabbling ducks and geese.

On the brushy vega-terraces between the canyon walls and the river, and also in the lower side canyons, brushy vegetation with occasional stands of larger trees provided the heavy cover niche preferred by a variety of mammal and bird species. Documented species from these niches included cottontail rabbits, gray squirrels, white-tailed deer, woodrats, cotton rats, gophers, bobwhite quail, turkeys, and some of the smaller raptorial birds. Many of the carnivores would have either hunted or had their living quarters in this niche.

The uplands were also used by human hunters ranging out from residence areas in the canyons along the region’s rivers. The cliff-canyon wall niche was tapped by human hunters for rock squirrels. The steep, rocky cliffs and upper canyon walls would have also provided excellent roost areas for some of the larger raptorial birds. The upland hills and upland flats were home to jackrabbits, pronghorn, and bison in the more open grasslands, with white-tailed or mule deer in brushier areas.

Skinning, Butchering, and Carcass Processing

Evidence for carcass processing by the Lower Pecos inhabitants is more firmly based on high quality data for cultural contexts that date within the past 3,000 years. The higher frequency and better quality of surviving bone fragments with remaining evidence of past processing behaviors insures better understanding of more recent phenomena, but an insight into behavior can be hazarded that is based on current data for earlier periods.

The Paleoindian deposits in Arenosa Shelter contained little bone that was unequivocally modified by humans upon which a statement about processing behaviors may be based with existing records. None of the bone fragments from Paleoindian context has been heat damaged. Few of the fragments show any cut marks related to butchering or carcass dismemberment. A single bison radius from stratum 42 exhibits a transverse cut mark that would allow the brachialis muscle to be separated. Three of the bone fragments from this same stratum show evidence of dynamic fracturing that could potentially be due to controlled bone breakage. Due to the deteriorated nature of the bone fragments and paucity of cut marks, helical fractures, or other direct evidence, it is unclear if such evidence is the result of secondary butchering of remains brought back to a rock shelter habitation locale or scavenging of bone fresh enough to provide edible marrow and raw material for tool manufacture. The bison bull from Feature 18 is problematic, but may represent a partially butchered single kill from undated, later Paleoindian context. It was accompanied by at least two small cobbles that may have been used in butchering or carcass processing. This enigmatic feature will be discussed more fully later in this chapter.

Elsewhere in the Lower Pecos, Bonfire Shelter provides a much clearer indication of Paleoindian large mammal skinning, butchering, and carcass processing, with evidence of large-scale bone breakage for marrow removal and bone grease production. Butchering of Bonfire Shelter's 120 bison from separate kill events of three mixed herds of bulls, cows, and calves evident in Bone Bed 2 carefully removed the forequarters and hindquarters by severing the connective tissues. Dessamae Lorrain (Dibble and Lorrain 1968; Lorrain 1965), the faunal analyst who worked with Dibble on the Bonfire Shelter analysis, noted the systematic dismemberment, separation of the carcasses into resulting butchering units, and then defleshing and bone breakage for marrow or bone grease. At least with these larger kill events, skulls were smashed. Several boulders used as anvils in bone breakage were documented in Bone Bed 2 and the underlying Bone Bed 1.

Evidence for Early Archaic carcass processing is non-existent at Arenosa Shelter. The end result of processing is present in the form of burned artiodactyl and canid bones found in cultural remains redeposited as a lag as a result of a high-energy flood event.

Lower Pecos Middle Archaic skinning, butchering, and carcass processing is more clearly understandable, based on faunal remains from Arenosa Shelter. Large gar, catfish, drum, and suckers were filleted in the process of being prepared for consumption. Medium to large mammal remains from this context are burned or exhibit helical fractures from bone breakage for marrow removal to use in tool making. At least one coyote or domestic dog was processed in this fashion, although the details of the preceding butchering process are unclear. Deer and pronghorns were systematically dismembered, butchered, and defleshed, with lower limb bones being retained for subsequent tool manufacture. While limited, carcass processing for smaller mammals such as rabbits included cutting of muscles at the hip joint to facilitate remove the hindquarters.

Late Archaic hunters and gatherers in the Lower Pecos are understood better because of a higher frequency of faunal remains at sites such as Arenosa Shelter. The processing of carcasses during this time period included careful skinning, dismembering, and defleshing of medium and large animals, including artiodactyls, canids, and jackrabbits. Medium to large animals were quartered before roasting. Butchering evidence for larger rabbits is such that it indicates skinning prior to disarticulation and dismemberment of the appendages, then defleshing of the dismembered carcass. The evidence for cottontails is somewhat similar, although skinning behavior may not include skinning the head out, and disarticulation of the shoulder and hip joints by cutting was not practiced on these smaller rabbits. An alternative method used with the smaller rabbits appears to have been severing the muscle masses on the proximal upper long bones, with subsequent breaking of the long bone diaphysis itself. Burning damage on long bone elements indicates exposure to heat with the meat still on the bone and supports an interpretation of secondary butchering following completion of cooking.

Large fish continued to be filleted in processing, possibly to allow drying the flesh. Heads of large catfish may have been also roasted following removal of the fillets. Catfish were carefully handled, with the musculature controlling the locking mechanism for the defensive pectoral and dorsal spines being disabled by cutting at the base of the spines.

The sampled portions of the Arenosa Shelter faunal collection did not include any bison remains in context from this portion of the Late Archaic. However, bison were apparently more numerous in the area during the Late Archaic and were preyed upon by the region's inhabitants. Bone Bed 3 at Bonfire Shelter is composed of the remains of at least one, if not several, cool season kills of relatively large mixed herds of modern bison that occurred within a short period of time (Dibble and Lorrain 1968; Lorrain 1965). The carcass processing for these very large herbivores was less systematic than that used during the Paleoindian period, possibly due to the massive amount of work necessary to process hundreds of carcasses in a short amount of time. Another reason may be that only primary butchering remains were found in the site. In any case, after skinning of the bison, their feet and hooves were cut off and discarded intact, then the limbs were removed not by cutting the connective tissues, but by smashing through the femur and humerus with chopping tools or cobbles. Heads were removed and the braincases of the skulls were smashed to remove the brains. The mandibles were also removed to access the tongues and marrow cavities in the mandibles themselves.

In the Terminal Late Archaic, the underlying skinning, butchering, and carcass processing methods used earlier in the Late Archaic continued, although there is more evidence for skinning of small to medium-sized mammalian carnivores, excluding skunks. The head areas received careful attention, in a manner that would allow the hide to be removed intact from the braincase, around the eyes, and from the snout. The patterning of skinning damage on the skulls indicates removal of the cartilage supporting external portions of the ear with the hide.

The Late Prehistoric – Historic evidence for skinning, butchering, and carcass processing is similar to earlier periods, with a continuation of secondary butchering of rabbits following cooking. The limbs of foxes and similarly sized animals were dismembered following being skinned. Fish continue to be cooked, with catfish defensive spines being specially treated as they have been since the Late Archaic. No clear evidence is present in the sample for continued filleting of fish. Artiodactyl carcasses continue to be defleshed with fat sources within the bone being tapped following fragmentation of the bone. Lower limb bones were treated in a similar manner to the upper limb bones, although care may have been taken to control the extent of breakage to preserve sufficient raw material for bone tool manufacture. The occasional bison that appears is treated in like manner, as may be the European domestic stock that becomes available within the past 300 years.

Special Topics--Evidence for Carnivore Modification

Many of the specimens analyzed for the current research exhibited signs of carnivore modification (cf. Schmitt and Juell 1994). The degree and extent of carnivore modifications in both collections is variable, but extensive ravaging of individual specimens is present. Almost twenty per cent of the faunal collection sample exhibited carnivore damage. Carnivore modification of bone is evident throughout the stratigraphic column at Arenosa Shelter, from a few bison fragments from Paleoindian context in stratum 42 to domestic sheep from Historic context in the upper-most strata.

Signs of carnivore modification vary from a few small tooth marks, most likely by small canids that may have included the domestic dog, to pervasive modification of the surfaces and edges of individual bone fragments, ornaments, or tools by deep tooth marks. In some cases, especially with smaller mammal remains or small fragments of large mammal remains, surfaces of element or artifact fragments have been shallowly pitted by the digestive acids of carnivores. Also present with rabbits and other smaller mammal remains are wholesale shearing of portions of elements or helical fracturing, for example the mandibles, scapulas, pelves, and long bones, in patterns documented to occur with avian or terrestrial predators. These particular patterns typically remove the diaphysis portion of long bones, leaving the proximal or distal epiphyses. Tooth perforations are also present in thinner segments of smaller mammal bones, included the calcaneum of jackrabbits. Crushing of portions of large mammal bones, scalloping of fragment edges, and certain types of edge polish on fractures are also present that round out indications of carnivore damage to almost 1,100 items in the faunal collection sample.

BONE MODIFICATION AT ARENOSA SHELTER

Deliberate modification of animal bone by prehistoric residents in the Lower Pecos was done for at least two purposes, only one of which resulted in a technological outcome. Subsistence modifications to bone resulted in damage from skinning, butchering, or fat removal activities. In many cases, residual indicators of these primary activities lingered when bone fragments resulting from subsistence activities were reused for a technological purpose. This was especially true of tools or ornaments that involved minimal technological alteration in their manufacturing process, such as the expedient tools or minimally modified long bone bead forms documented in the Arenosa Shelter archaeological record.

The manufacturing process for more formalized implements and ornaments that involved extensive surface modification or reshaping was a second purpose for which Lower Pecos residents deliberately modified bone. Although this manufacturing process emanated from subsistence activities used mainly to secure foodstuffs, skins, feathers, connective tissue, and other animal materials for sustenance or other day-to-day needs of food, clothing, or shelter, its end results were not directly tied to subsistence activities. Exhibiting a considerable time depth, the process results added to the products immediately available for use or supplied means of producing additional items needed by the indigenous residents of the canyon lands of the Lower Pecos.

Procurement of Raw Material for Bone Technology

Based on the current research, raw material for both expedient and more formal implements and ornaments were obtained from subsistence activities practiced by Lower

Pecos residents during the Middle Archaic to Historic – Late Prehistoric period. That being said, apparently not all bone residual from subsistence activities was suitable for all uses or forms that were considered by the indigenous crafters of implements and ornaments in the Lower Pecos.

Surviving fragmentary implements and ornaments, their preforms, and manufacturing byproducts sampled from the Arenosa Shelter artifact collection reveal patterns of potential raw material preferences by Lower Pecos residents in choices of raw material for particular forms of artifact being manufactured. Fragmentary implements or manufacturing byproducts distinguished during analysis of the faunal collection sample corroborate this supposition.

Decorated and undecorated beads were primarily manufactured from long bones of small to medium-sized mammals that included rabbits and carnivores, all hunted for other purposes. Except for occasional aberrancies, such as beads manufactured from deer antler or phalange segments, this remained true throughout the Middle Archaic to Late Archaic. Long bones from medium to large birds also formed the basis of undecorated bead production. Hawks, turkeys, and aquatic birds were most often chosen for bone bead production, possibly due to the size, structure, and smoothness of the raw material itself.

Implement raw materials were primarily chosen from the ample supplies of skeletal material that resulted from subsistence hunting of deer-sized artiodactyls. Based on the frequencies of artiodactyl-based forms and their manufacturing byproducts in the Arenosa Shelter bone artifact collection sample, this choice by Lower Pecos residents was true whether those implements were to be expediently crafted for short-term use or more formally manufactured for more extensive use over a longer period of time.

Most tools were manufactured from artiodactyl long bone, quite often the metapodials. Specific forms of implements appear to have required use of the metacarpal, others the metatarsal. It is not possible to determine whether the choice of artiodactyl metapodials for specific tool forms was based only on the relative availability of this specific raw material. An alternative consideration might be whether its underlying physical characteristics could influence how trouble-free it was to use as a raw material in implement manufacture or how durable the material might be in use.

Manufacture of other specific formal tool forms used the ribs and long bones of artiodactyls or segments of deer antler. Billets used in flint knapping were manufactured from antler beam segments. Antler pressure flakers used tine tip segments that had modifications to their tips. Long bones from medium to large mammals were also occasionally retained for use as tool material, although its use was much less frequent than that of artiodactyls. Bony spines from fish, most often the pectoral spines of catfish, were used for specific narrow implement forms. These implements required a lesser amount of work to fashion into final form versus the larger and more formalized tools manufactured from artiodactyl metapodials. Compared with the expedient tools fashioned from butchering waste, the catfish spine implements were intermediate in manufacturing complexity and comparable to a few of the simpler artiodactyl-based tool forms that could be easily made using tool manufacturing debitage, rib fragments, or other long bone fragments left from subsistence activities. Expedient tools used artiodactyl long bone fragments remaining from subsistence activities, often the helically fractured remnants that were the byproducts of bone marrow removal. Some exhibited utilization of an un-worked edge, others had minimal modification to shape or re-sharpen a working edge.

Techniques of Manufacture for Bone Artifacts

Due to less complexity, the manufacturing techniques applicable for bone ornaments in the Lower Pecos will be discussed before that for bone implements. Undecorated bone ornament forms at Arenosa Shelter are documented from Middle Archaic upward through the Historic – Late Prehistoric contexts. Decorated bone ornaments are a Late Archaic to Historic – Late Prehistoric phenomenon. As all documented decorated bone ornaments in the Lower Pecos are beads and the basic techniques of manufacture for most undecorated and decorated bone beads were similar, with decoration adding a finishing step, manufacture of decorated beads will be discussed as additional variants of the manufacturing process for undecorated bone beads.

Manufacturing of undecorated bead forms in the Lower Pecos Archaic, Late Prehistoric, and Historic periods was a continuum that included at least three potential shaping and smoothing steps prior to bead use. The overall manufacturing process for undecorated beads centers on the transformation of diaphyses of tubular skeletal elements into finished ornaments. A key point in this process is the decision to use the portions of diaphyses that contain the medullary cavity. The process for manufacturing undecorated bone beads is portrayed schematically in Figure 31.

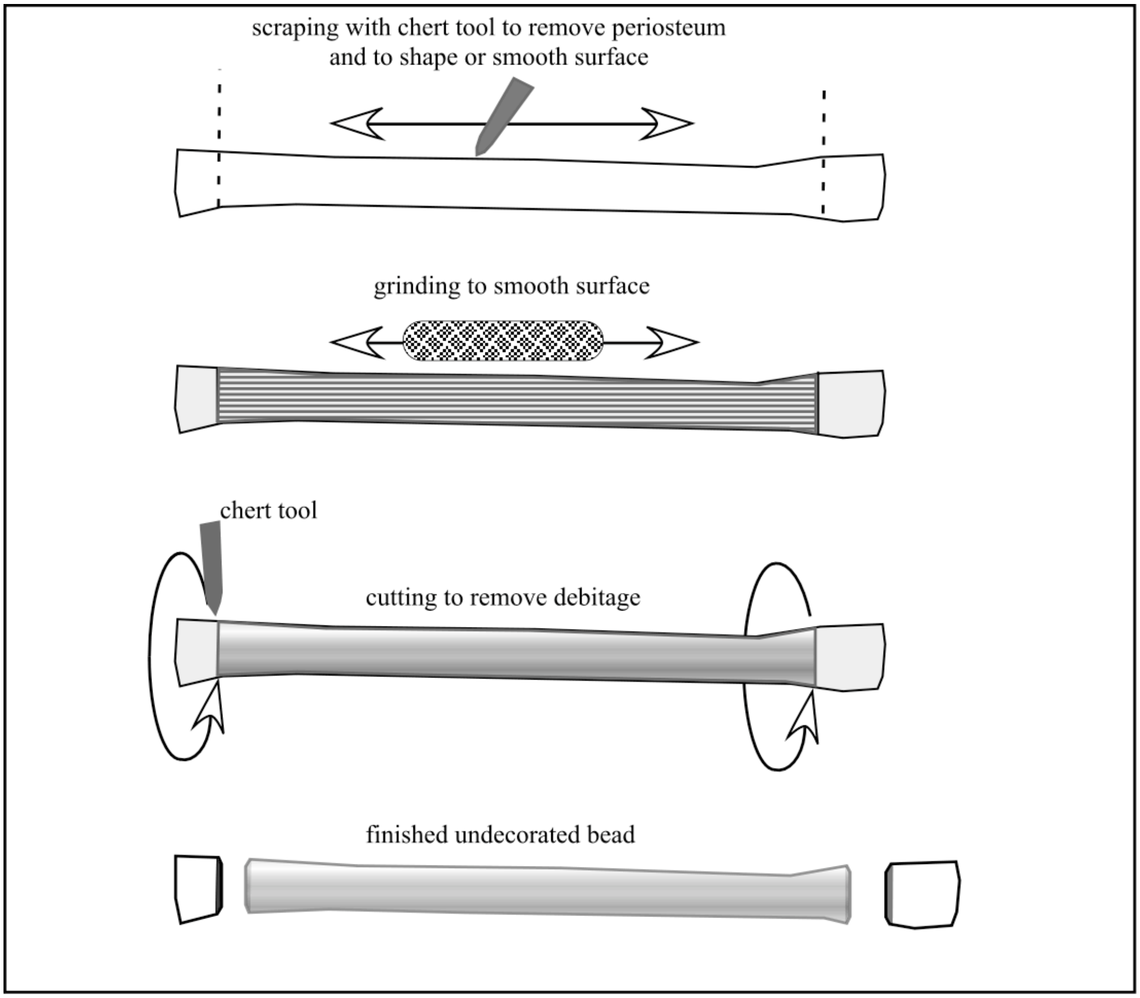

Figure 31: Schematic of Manufacturing Process for Undecorated Bone Bead Forms in Lower Pecos.

In a linear fashion, the steps involved in manufacturing of most undecorated bead forms was:

1) selection of a suitable long bone or metatarsal from a small to medium-sized mammal or medium to large-sized bird;
2) longitudinal scraping to remove the thin periosteum layer of connective tissue from the surface of the bone and to begin shaping the surface of the bone;
3) grinding to final shape;

4) circumferential cutting of annular grooves to allow snapping off unneeded portions of element, including the epiphyses, as debitage;
5) final smoothing of fresh cut surfaces on ends and other areas by grinding or polishing, as needed.

Where it was fully implemented, variations in the outcome of the manufacturing process were related to decisions concerning the desired overall shape of finished undecorated beads. This resulted in at least six different groups of beads defined analytically on length vs. width characteristics. Other variations were evident in a number of cases where a) raw material choice did not include long bones or metatarsals of birds or small to medium mammals, b) steps were restricted in the extent to which they were implemented on individual beads, c) steps were sequenced differently, or d) steps were not used at all. If bone tubes are considered to be preforms for beads, they exhibit implementation of only steps 1 and 4.

The first of these variations allows discussion of beads that were manufactured from artiodactyl bony elements, either phalanges or deer antler segments. Rare in the bone artifact collections from Arenosa Shelter were several undecorated beads manufactured from deer or pronghorn. The process of fashioning beads from segments of mule, white-tailed, or hybrid deer antler involved a choice of tine segments that had cancellous bone interiors. Seasonally, white-tailed deer and mule deer differ on the presence of this characteristic (Jerry Cooke, September, 1998:personal communication). White-tailed deer have this condition during the summer growth season for their antlers, but it disappears as the antlers complete their growth and harden out. The condition is present during the entire time that antlers grow and are in place on mule deer.

In creating beads using antler segments with cancellous interiors, the manufacturing process removed tine tips from the beam by grooving and snapping before longitudinal scraping was applied to the medial and proximal portions of the bead to smooth and shape them. The tip was then ground to a slightly rounded shape that penetrated the compact bony exterior of the tip. The cancellous interior of the antler was hollowed out, although it is unclear what means were used to accomplish this step. The process resulted in a tapered tubular bead.

A similar process that used bone instead of antler was also used to fashion tapered tubular beads from artiodactyl phalanges during the Terminal Late Archaic. The manufacturing steps involved longitudinal scraping of the element to remove the periosteum layer and begin shaping of the body of the bead prior to grooving and snapping away of the epiphyses as debitage. Final grinding smoothed and shaped the beads to a more slightly rounded form.

Restriction of the extent and intensity of application of manufacturing steps partially forms the basis of potential variation in undecorated bead forms. Limiting the extent to which grinding or scraping steps are applied alters the final shape and smoothness of the undecorated bead form. Variation is noted in the Arenosa Shelter analysis sample where grinding is present on ends only, on one end and in the middle, or other combinations. Similarly, scraping is sometimes present only on part of an observed bead.

Another variation in implementing the manufacturing process forms a continuum with the just-discussed partial presence or absence of manufacturing steps. This variation involves a re-sequencing of the steps involved and potentially deletion of steps altogether. Re-sequencing of the steps may be involved in crafting antler beads during the Late Archaic. Tip grinding preceding removal of the cancellous interior rather than as a final step in manufacture. In some cases, longitudinal scraping is not used to remove the periosteum or to initially smooth bead forms. In other cases, grinding does not appear to have followed the longitudinal scraping step or was used only on ends.

The addition of relatively simple decorative elements to bone beads in the Lower Pecos Terminal Late Archaic and Historic – Late Prehistoric draws upon techniques that are already in use in their manufacturing sequence. These involve cutting, typically termed incising, of additional annular grooves along the length of the bead body. The decorative grooves are more shallowly incised than the terminal groove and snap fractures that define the ends of the bead. At least two forms of incised beads are presently defined, differentiated on the basis of wall thickness. While not typical, manufacture of incised beads may also involve additional smoothing steps using grinding, especially on larger beads fashioned from thicker elements that allow for incising of deeper decorative grooves. A final decorative bead form present in the Arenosa Shelter bone artifact collection sample is a small, barrel-shaped, faceted bead created from jackrabbit foreleg or hawk wing elements. Used in the Late Archaic and Terminal Late Archaic, the manufacturing process for this form elaborates on the process used for similarly sized undecorated beads by the use of grinding to create multiple facets around the circumference of the bead body. The technique of creating small bevels is also used in the manufacturing of implements and will be discussed further when that process is taken up. Figure 32 schematically portrays the manufacturing process for incised and faceted bead forms.

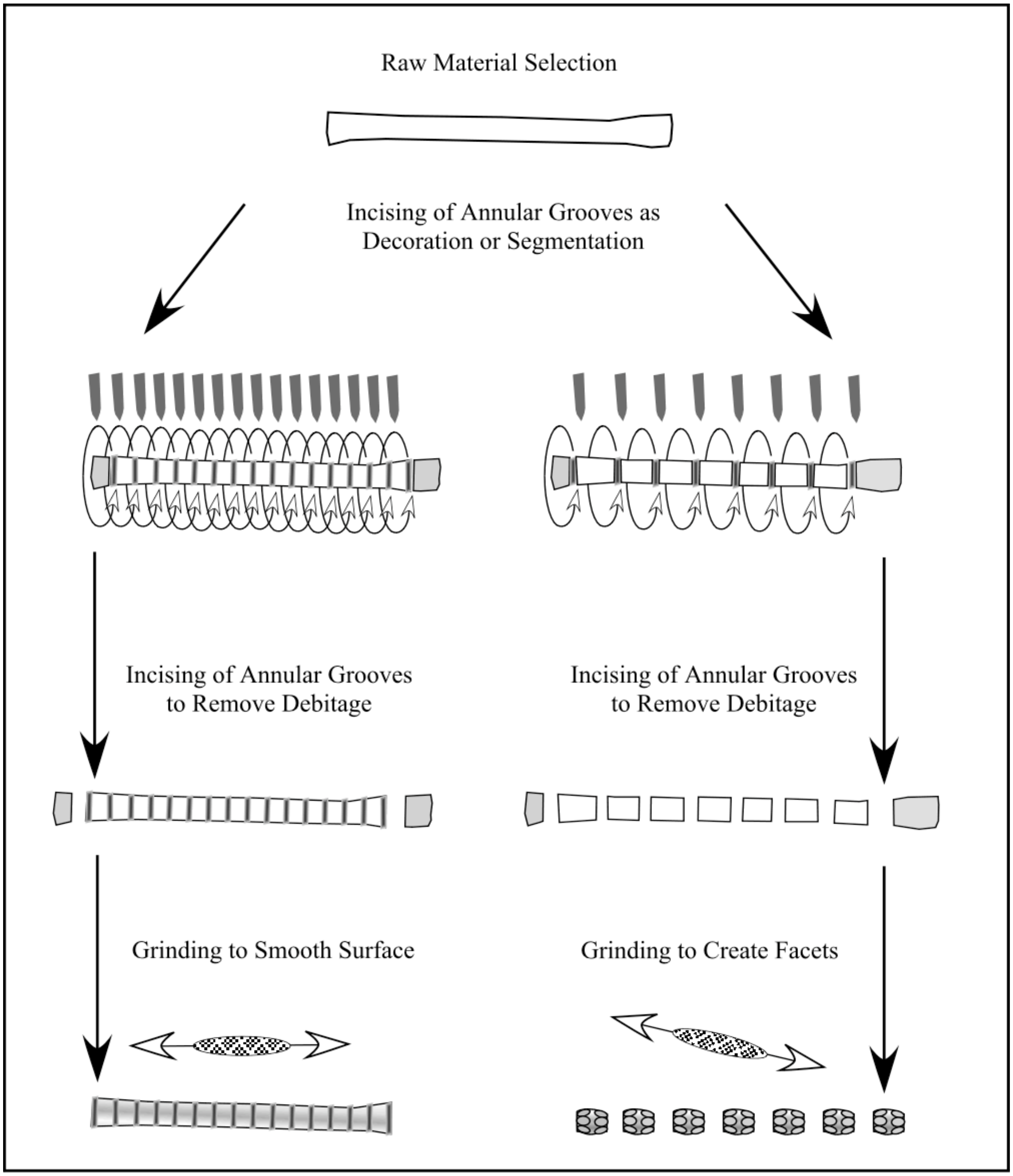

Figure 32: Schematic of Manufacturing Process for Decorated Bone Bead Forms in Lower Pecos.

At least two separate manufacturing processes are evident for implements in the Lower Pecos during the Archaic that vary considerably on formality of procedures. An informal manufacturing process is present and used for quick crafting of simple tools apparently intended for short-term use. These expediently made tools were relied on for a variety of tasks from butchering and hide working to processing of the region's vast array of silica-rich plants. A second manufacturing process for more formal tool is more involved and the tools produced by it saw much more extensive use. At least some tools exhibit characteristics of both processes and will be discussed as a potential variant.

As its raw material, expedient tool manufacture utilizes helically fractured butchering waste from medium to large mammals, primarily artiodactyls. Following selection of a suitable fragment, working edges are shaped using scraping or hard-hammer percussion flaking. In some cases, existing edges of helical fractures are initially utilized with no further modification until resharpening is necessary. At that point, the dulled edges are resharpened using hard-hammer percussion flaking.

Formal implement manufacture is also based on subsistence activity byproducts that are primarily from artiodactyls, although fish and carnivore remains are also present. Most implements use as their raw material a metapodial from a deer or pronghorn-sized artiodactyl. Few of these metapodials are subjected to marrow removal procedures as part of subsistence activities involved in butchering. Specific choices appear to be involved in raw material choice for various implement forms. Artiodactyl metacarpals are used for certain forms and metatarsals are used for others. Additional implement forms use catfish pectoral spines, deer antler segments, and indeterminate elements from medium to large-sized mammals.

Implement manufacture uses some of the techniques that are also used in ornament manufacture, including in step-wise fashion:

1) selection of suitable fish bony spine or long bone from medium to large mammal;

2) cutting of grooves and snapping to separate the implement blank from debitage;
3) scraping to remove the periosteum and to begin initial shaping of the implement blank;
4) grinding to smooth and further shape the implement blank;
5) polishing, as needed, to finish implement.

Variations in this process and its outcome are related to decisions concerning overall shape of finished tool, its intended use, and the implement's current stage in its use-life. At least 23 implement forms are defined analytically on the basis of physical characteristics that include length, width, thickness, tip form and cross section, and manufacturing techniques. As with ornaments, variations are evident where a) raw material choice did not include artiodactyl metapodials, deer antler, catfish spines, or deer ulna, b) steps were restricted in the extent to which that they were, c) steps were sequence differently, or d) steps were not used at all.

As long implement forms based on artiodactyl metapodials form the bulk of the tools from the Lower Pecos, at least as viewed through the lens of the Arenosa Shelter bone artifact collection sample, variability in their manufacturing techniques will be discussed first. Forms based on artiodactyl metacarpals include awl/bodkins, bodkins, bodkin/perforators, and spatulate/bodkins. The primary difference between these implement forms is in the tip cross-section and profile. Spatulate/bodkins have a generally oval distal cross section and may have a tip profile that varies from rounded to sharp. Other metacarpal-based forms vary, with bodkin/perforators also having a tapering oval cross section with a long, narrow, sharply tapered tip profile. The awl/bodkin and bodkins are similar to the spatulate/bodkin, but differ in length to width ration as their overall length differs.

The process of manufacturing these metacarpal-based tools differs from that used for those used for artiodactyl metatarsal-based tools in the portion of the metapodial isolated as an implement blank. At least two techniques may be used to separate blanks from the original skeletal element. Grooving and snapping is used to separate the debitage from the distal epiphysis and diaphysis intended for production of these tools. Alternatively, chopping to achieve the same end is evident on some specimens. The medial and distal portion of the blank consists of posterior aspect of the metacarpal diaphysis. Following initial shaping of the blank by longitudinal scraping, distal and medial portions of the tool are ground to their final profile and U-shaped to oval or circular cross-section. Additional grinding occurs on the proximal end where anatomical features including the lateral condyles and intra-condylar groove are smoothed. In some cases, smoothing occurs to such an extent that all compact bone is removed and the underlying cancellous bone is exposed.

Metatarsal-based tools generally fall within the spatulate form. Derivatives of this form, including the narrow spatulate, spatulate/perforator, and creaser spatulate, are manufactured from artiodactyl long bone fragments identifiable as metapodial, but not specifically as metatarsal or metacarpal due to the absence of appropriate anatomical features. Other spatulates use the ulna or helically fractured butchering waste as a raw material that is identifiable as other artiodactyl long bones because of overall shape, size, cross section, and anatomical features present. Metatarsal-based implements retain anatomical features that allow identification of the proximal portion of this element.

Blank preparation for these tools more typically uses groove and snap fracturing than chopping to longitudinally section the metapodial or metatarsal. The metapodials are sectioned in half by grooving and snapping on anterior and posterior aspects, with at least one of the linear groove and snap fractures utilizing the anatomical medial groove on the element's cranial aspect. Some tools are obviously prepared by quartering the metatarsal, whether during the initial blank preparation or during subsequent refitting or rejuvenation of longitudinally broken tools. Other tools have the proximal portions modified by a transverse groove and snap fracture to create a straight to slightly curved proximal margin. Additional shaping steps are similar to those used for metacarpal-based tools including variations where shaping and smoothing obviously only use longitudinal scraping and delete the following grinding step.

Incised spatulates are present, but rare, in Middle Archaic to Historic – Late Prehistoric context and are fashioned from wide, relatively flat portions of the lateral and medial aspects of metapodials. Their manufacture is similar to other spatulates, especially those that have the proximal articular surfaces removed by grooving and snapping, prior to incising of cross-hatched, chevron, or parallel line decorations across the proximal end or along proximal lateral margins. Due to subsequent use, the decorations appear to have smoothed.

Ulna spatulates from Terminal Late Archaic context are prepared by helically fracturing the diaphysis of the element to remove the distal half, leaving the proximal portion as the implement blank. Longitudinal grooving under the lunar notch may modify the tool blank, and then the tip section is shaped by longitudinal scraping to produce the required cross section and profile. Grinding may also be used to smooth the distal portions of the implement.

The distally notched spatulate is a special case that occurs in Middle Archaic context. While the overall tool form is variable because it appears to utilize helically fractured butchering waste as its raw material, a specific modification appears in each case. The distal portion of the implement exhibits a bifurcation of up to 10 mm that is scraped into the surface of the bone, with the resulting tips having a blunted profile and oval cross section. The tips are relatively equivalent in length. A similar deep bifurcation is involved in creation of potential bone fish hook preforms during the Middle Archaic that have tips of dissimilar lengths. These implements are similar in technology to those reported by Harrell (1983) in Central Texas.

Perforators are present in Middle Archaic to Terminal Late Archaic contexts and typically utilize a long narrow segment of artiodactyl metapodial or other long bone as a blank. In some cases, the original element is identifiable as a metatarsal due to retention of part of the proximal articulation. Grooving and snapping is used to create the long, narrow blank, occasionally by refitting of a larger, wider tool that was broken. An occasional use of a suitably robust dorsal or pectoral spine from a drum or large sucker is also documented from similar context. The narrower tip section of this tool form is shaped by scraping and smoothed by grinding prior to use.

Catfish spine spatulates and perforators are special implements found in Terminal Late Archaic context. These forms use pectoral spines from medium to large catfish as an implement blank that needs only minimal additional work to create a finished tool. In some cases, the diaphysis of the spine is longitudinally scraped, especially on cranial and caudal aspects to remove the teeth that are present. On more robust specimens, the tip of the diaphysis is then shaped using scraping. Grinding is the final shaping and smoothing technique used to create the desired tip profile and cross section.

Needles use as their basis either narrow skeletal elements, such as the ulna of an artiodactyl or medium to large canid, or an artiodactyl long bone. Blank preparation of these Terminal Late Archaic implements is by grooving and snapping the element longitudinally where necessary to achieve a long narrow shape. The distal portion of the resulting blank may be then scraped and ground to remove the periosteum layer and to shape and smooth its profile and cross section.

Pressure flaking tools of bone are similar in manufacturing process to other long, narrow implement forms, although the exact blank preparation method is unknown. Although very rare in Terminal Late Archaic and Historic – Late Prehistoric context, these implements have rounded tip section profile and cross section shaped by scraping and smoothed further by grinding.

Other appendicular skeletal elements from artiodactyls form the basis of implement forms involved in hide working in Middle Archaic and Terminal Late Archaic contexts. Raw materials for the beamer and beamer/flesher forms are obtained from portions of the scapula, rib, and indeterminate bone with blank preparation by grooving and snapping, helical fracturing, and other means. Grinding or bifacial flaking to a final form shaped the blanks.

The rib tool form is another Terminal Late Archaic form. Its blank was grooved and snapped from distal segments of artiodactyl ribs prior to the working edge being scraped to final shape.

A final artiodactyl metatarsal-based implement form has spatulate manufacturing debitage as its raw material. The beveled and faceted woodworking form is fashioned from a blank utilizing cast-off spatulate manufacturing debitage that has a tip section scraped to shape. Final smoothing and profiling on the distal tip is by grinding of multiple facets.

To complete the discussion of implement form manufacturing techniques, another enigmatic Terminal Late Archaic form must be discussed, the wedge. This relatively flat form has a triangular profile that exhibits three step-wise grooves between its base and apex. Fashioned from fragmentary artiodactyl phalanges and other relatively flat bone fragments, the wedge blank is prepared by grooving and snapping. Subsequent shaping is by transverse grooving, scraping, and grinding to the final profile and cross section.

A schematic of manufacturing processes used in creating implement forms is found in Figure 33.

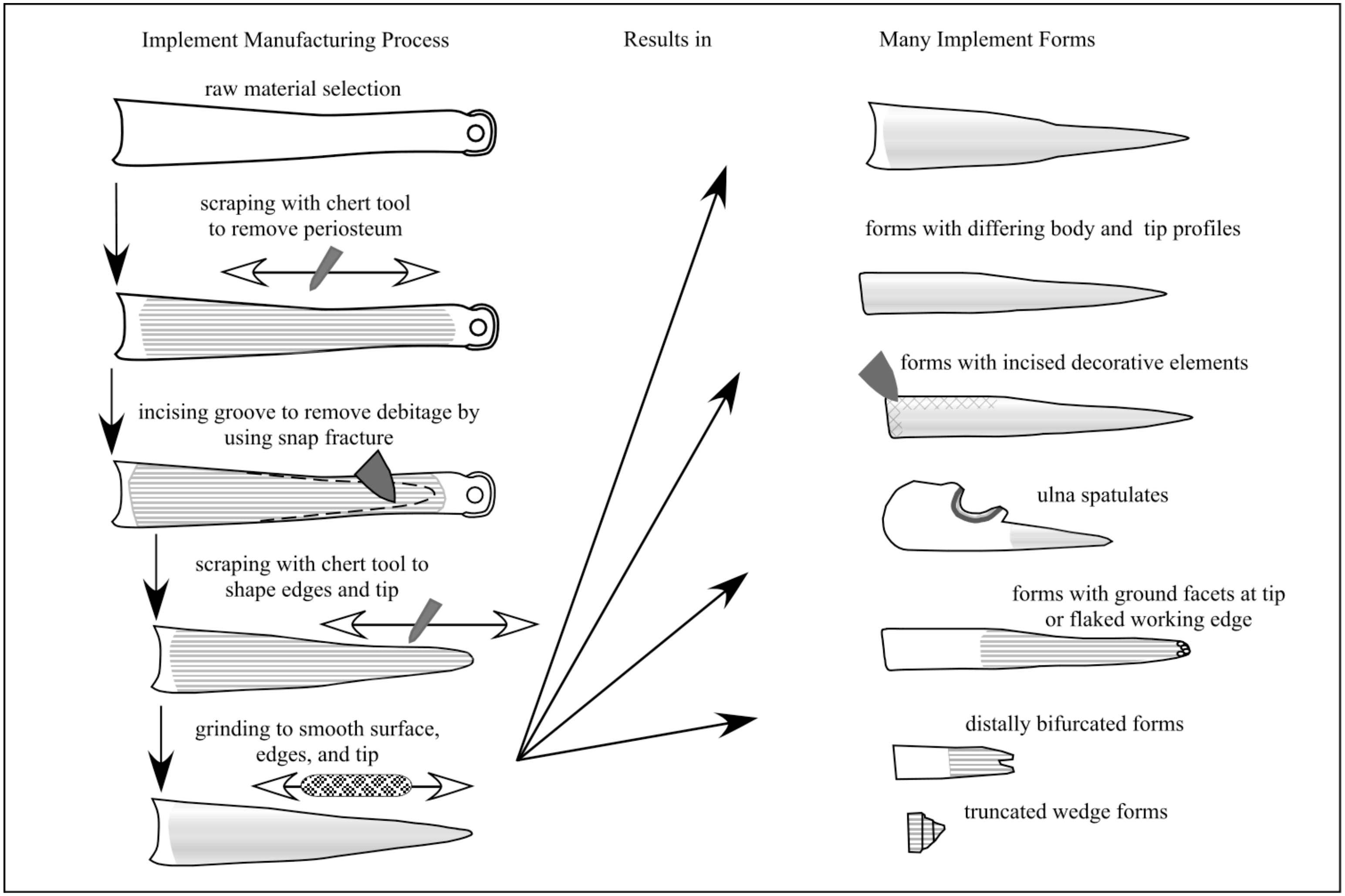

Figure 33: Schematic of Lower Pecos Bone Implement Manufacturing Process.

Function of Bone Technology in Tool Kit and in Hunting/Fishing System

Fortuitous preservation conditions allow researchers to investigate problems using perishable materials from Lower Pecos archaeological sites including Arenosa Shelter. Such is the case with the current research. The function of bone technology in the prehistoric tool kit and system for hunting and fishing may be addressed using bone fragments from Arenosa Shelter.

The archaeological record in the upper strata at Arenosa Shelter preserves a wealth of data about the prehistoric technological role of bone. The prehistoric inhabitants of the Lower Pecos fit bone technology into a broader technological system to exploit the region's varied resources.

Bone and antler tools were incorporated directly into the manufacture of tools from other materials in the Lower Pecos. As such, the prehistoric technologist was able to craft lithic implements using greater precision necessary in soft hammer percussion and pressure flaking techniques.

Implements made from bone and antler also assisted directly in the gathering, processing, and manufacturing of plant fiber-based textiles and in the processing of wood to craft small items. At least some of the Arenosa Shelter bone artifact forms represent implements that were used directly in collecting tree bark or fiber from the region's desert succulent plants. Spatulate forms aided in processing desert succulent leaves, allowing fiber to be stripped and separated for use in cordage and textiles. Two forms were used in woodworking to split and shape small pieces of wood for other uses. Distally notched or bifurcated spatulate forms may have had a role in textile manufacture, including netting. The presence of long sections of netting that used both cordage and small wooden supports is documented from bundled specimens recovered from the

Lower Pecos's dry caves and rock shelters (Schuetz 1961, Shafer 1986). While an exact use for these long nets is not known, possible uses in game drives or in fishing are within reason and known from other areas in the arid lands of the American Southwest. Other smaller nets have been interpreted to be much the same as modern cast nets that are thrown to envelop prey.

Once the prehistoric inhabitants of the Lower Pecos caught small and large game animals, their remains entered the subsistence economy for human consumption and, potentially, byproducts from that consumption entered the technological system. In processing game animals for consumption, their skins were removed for later use, meat was cut from the carcasses to be eaten immediately or preserved for future consumption, and sinews and other connective tissues were separated for use where needed. Finally, fat sources contained in the skeletal elements themselves were tapped for human consumption and recovered. The remnant bone fragments were left available for other uses that included raw materials for technological use.

The bone implements fashioned by the region's prehistoric inhabitants definitely functioned within this process of transforming the products represented by each animal into a form usable to humans. Informally or expediently made forms necessary to assist in butchering of fish or game animal carcasses in Lower Pecos prehistory are documented in implements present in the Arenosa Shelter artifact collection. Other informally or expediently fashioned forms were used in processing skins from those animals, as were more formally manufactured forms. Formally manufactured spatulate forms functioned in working of hides, whether freshly obtained and retaining their fur, freshly defleshed, or dried. Some of these spatulates were used to perforate hides to be sewn together. At least some of the spatulates were used in working with sinews from animal carcasses obtained by area hunters, possibly to be used in sewing or other uses as a parallel to plant fiber cordage.

Finally, the role of ornaments, bone tubes, and decorated implements in the region's hunting and fishing system may be at least partially addressed. Decorated spatulate-form implements are similar in manufacture to undecorated forms, but incised linear motifs may have a connection with the region's abundant and long-lived rock art tradition. Although conjectural, ornaments such as beads may have functioned in the hunting and fishing system as markers of group identity or other signifiers in the same fashion as rock art (Boyd 2003). Bone tubes are enigmatic and apparently may have functioned at least partially in a ritual role.

Provisional Interpretation of Uses

Based on the fore-going technological and use-wear analysis of the Arenosa Shelter bone artifact collection sample, a provisional interpretation of uses for its contents may put forth at this point. Ornaments will be discussed first because less complexity is involved in doing so. The 40 bead forms identified in the sample differ primarily in morphology and may be separated into four main groups on the basis of form, manufacturing techniques, and raw material. The groups are large beads based on artiodactyl antler tines and phalanges, small to medium decorated beads, small to large undecorated beads manufactured from bird bone, and small to large undecorated beads manufactured from small to medium-sized mammals. Based on the use-wear analyses for these beads that was presented in Chapter 6, the provisional interpretation of their function was as surface decorations for plant fiber-based textiles, hides used as clothing or containers, and as stand-alone strands of ornaments.

A provisional interpretation of function for implement forms is, by necessity, much more complex due to varied morphology of the forms and documented use-wear signatures. Expedient implement forms are varied in morphology and use, but provisionally are identified as being used for primary and secondary butchering, hide working of hides with attached hair, and plant fiber processing.

More formalized implements are also widely varied in morphology and documented use-wear. Provisional uses for implements fashioned from antler include pressure flaking and soft-hammer percussion techniques in flint knapping, wood working, and working of both dry hides and hides with attached hair. The following discussion of provisional interpretation of functions for formalized bone implements from the Lower Pecos follows the pattern of the fore-going discussion of their manufacturing techniques that recognized the variability in form and raw material sources. Artiodactyl metacarpal-based implement forms that include the awl/bodkins, bodkins, bodkin/perforators, and spatulate/bodkins vary in their uses, but provisionally were used in procurement and processing of silica-rich plant fibers from desert succulents and tree bark, textile manufacturing, or working of dry hides or hides with attached hair.

Spatulate implements are provisionally are identified as being used in many uses. These included procurement and processing of silica-rich plant fibers from desert succulents and tree bark, textile or cordage manufacturing, wood boring in soft woods, working of hides that include fresh, dry, or hides with attached hair, sinew dressing, sewing, or pressure flaking in flint knapping. Artiodactyl metatarsal, metapodial, or long bones were used to manufacture spatulates and related forms, including needles and perforators. Although they use considerably different raw materials, catfish spine-based spatulate or perforator forms have similar functions as those made from artiodactyl elements and are provisionally identified as being used in production of textiles, and working of fresh or dry hides. Distally notched spatulates function as bark strippers, sinew dressers, or hide dressers. Rib tools were used for woodworking, most likely with the region's softer woods rather than hard woods such as oak or pecan. Beamers and fleshers made from indeterminate bone or rib fragments have use wear related to meat or fresh hides and their function is provisionally identified as hide-dressing.

Although using similar manufacturing techniques to distally notched spatulates, the function of the more deeply bifurcated longitudinally split specimen in the sample is provisionally identified as a fish hook preform due to its similarity to like items identified by Harrell (1983) in Central Texas. Final provisional function assignments are for the spatulate manufacturing debitage that has been modified with a beveled and faceted tip section and a small wedge-shaped form. Each of these has use wear consistent with woodworking tools. The beveled and faceted form is provisionally identified as a bark stripper. The two wedge-shaped implements are enigmatic, but provisionally identified as wood working tool with an unknown specific function.

SPECIAL TOPICS

Two special topics will complete the discussion of the current research. Within the Arenosa Shelter faunal collections, two unique lines of evidence were happened upon during the research that afforded the author to investigate and more fully understand subsistence behaviors used by the prehistoric people's who occupied the Lower Pecos region for so long. Both of these lines of evidence center on decisions made by the prehistoric residents about how fauna was treated during carcass processing that processed the successful outcome of a hunting or trapping endeavor. The clearer, more recent line of evidence will be discussed first. The final line of evidence is from Paleoindian context and is more enigmatic.

Evidence of Caping, a Specialized Skinning Behavior

While the author analyzed specimens from the faunal collection included in the current research, certain patterns emerged among the remains of mammalian carnivores present in the sample. Among the 110 fragments of foxes, dogs, coyotes, raccoons, ringtails, badgers, skunks, and possibly larger carnivores, skinning damage was observed on remains of all species except the skunks. Among these remains modified by prehistoric Lower Pecos hunters and gatherers, 35 fragments represented cranium or mandible remains. Twenty-seven of these cranial or mandibular fragments were from Terminal Late Archaic context in strata 3 – 5. Of this group of carnivore specimens, eight exhibited skinning damage. The intra-species similarity was striking in the patterning of cutmarks on the mandible—transversely along its ventral margin, transverse chopping on the ventral margin in the vicinity of the P_2 to M_2, and cutmarks adjacent to the condylar fossa. Similar patterning of cutmarks was also noted on skull elements. Cutmarks on the cranium were placed between the tooth row and infraorbital foramen or zygomatic arch, along the supraorbital arch and temporal line, along the margins of the orbits, and the edges of the infraorbital canal (see Figure 34).

Shallow cutmarks on the skull fragments are in positions to allow separation of hide from the cranium itself. Of interest is the location of cutmarks posterior and medial to orbits that would allow the pinna or auricula (external portions of ear) would be removed with the skin. The deep cut marks or chop marks on the ventral margin of the mandible in the vicinity of the P_2 to M_2 teeth do not represent disarticulation damage, nor are they similar to other more faint cutmarks on the mandibles and crania. They are, however, in a position directly ventral to the base of the muzzle and removed the anterior portions of mandible. None of these patterned cutmarks could be considered to represent disarticulation damage except for the cutmarks on one of the mandible specimens in the vicinity of the temporomandibular articulation.

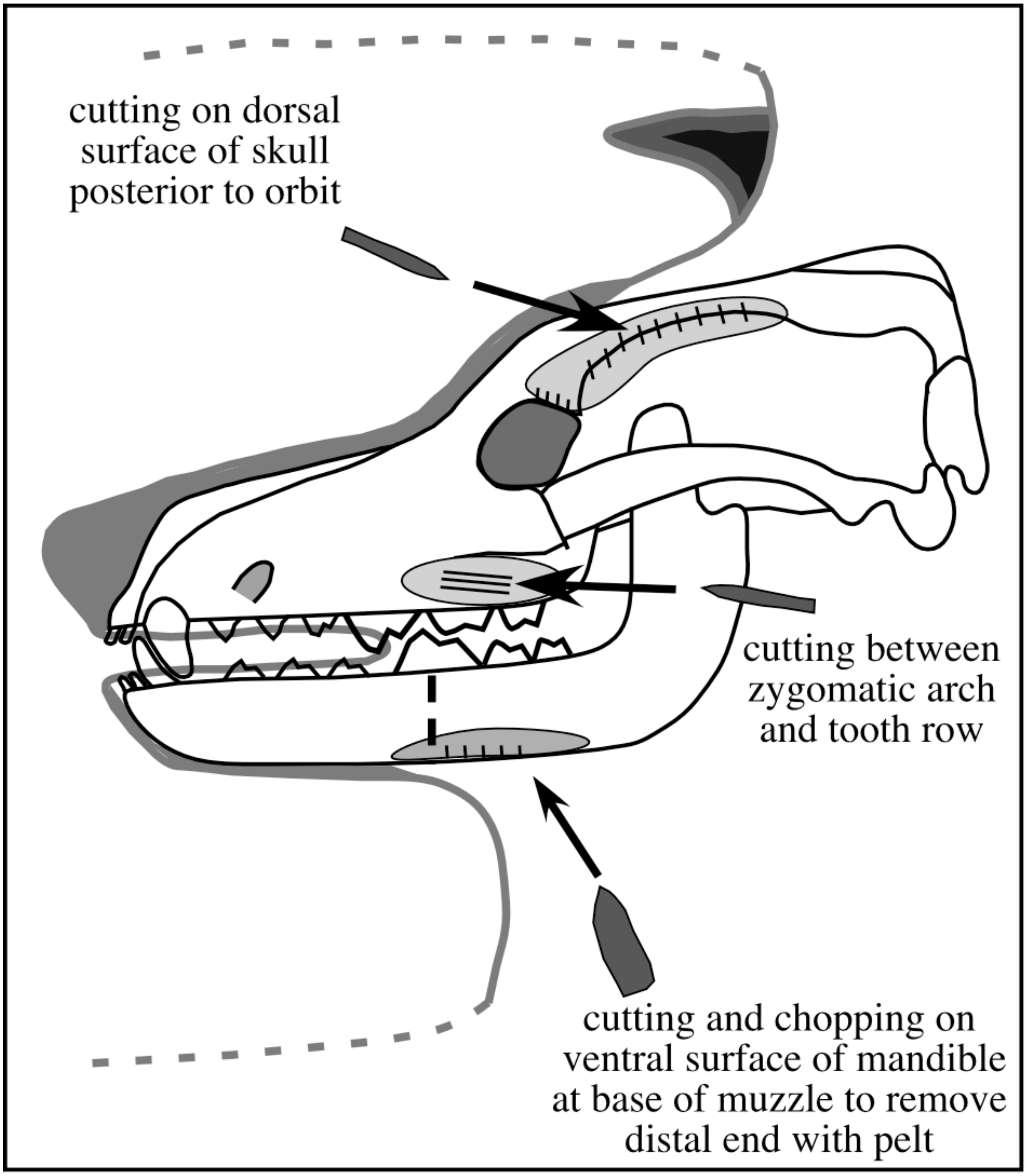

Figure 34: Evidence for the Specialized Skinning Behavior Known as Caping on Carnivore Cranial and Mandibular Materials from the Terminal Late Archaic at Arenosa Shelter.

Taken together, these three rather distinctive sets of cut and chop marks represent a single pattern of damage related to a specific skinning behavior. Other lines of evidence from the dry rock shelters and caves of the Lower Pecos and adjacent regions are informative at this point. The Lower Pecos and Trans-Pecos collections of the Texas Archeological Research Laboratory and the Witte Museum both contain skins of carnivores that include the intact features of the face, including ears and muzzles (D. Creel, January, 1998:personal communication).

Used in conjunction with the current analysis, these additional lines of evidence point to a step in skinning and carcass handling that requires a specific decision to include the complete face of the animal being skinned. This type of skinning is termed caping (Binford 1978:152; Field-N-Water.com 2004; Leach 2004; World Class Outdoors 2004). The osteological evidence from Arenosa Shelter reveals previously undocumented information about how pelts from small to medium-sized carnivores were removed with intact facial features. While not directly reported from the Lower Pecos region to date, ethnographic and archeological information from the Plains region records the results of a practice of small mammals and birds being similarly skinned to leave facial features intact. Importantly for potential interpretation of uses of similar pelts in the Lower Pecos region, pelts of small carnivores from the Plains were stuffed and prepared for use as medicine bundles, personal fetishes, and ceremonial adornments (Ubelaker and Wedel 1975).

The abundant Lower Pecos rock art has numerous representative depictions of carnivores, including felids and canids (Boyd 2003:95-105). Importantly, Campbell (1958:60) recognized similarities between anthropomorphic depictions in Pecos River-style rock art and paraphernalia worn by Historic period mescal bean cult practitioners. These similarities included fox skins wrapped around the waist of cult members and draped over their arms (Boyd 2003:89). Mescal beans, as seeds of the Texas mountain laurel (*Sophora secundiflora*) shrub are known, have been recovered from Archaic to Historic contexts in dry caves in the region, including Hinds Cave, Eagle Cave, Fate Bell Shelter, Coontail Spin, and Zopilote Cave (Boyd 2003:84-95).

Among hallucinogenic plant remains from the region are peyote and *Datura* sp. Boyd (2003) notes that both are associated with shamanism throughout Mexico and the American Southwest. *Datura* seeds were found in Hinds Cave in Middle Archaic context approximately 4,900 years ago (Dering 1979). Boyd and Dering (1996) identify the Middle Archaic Pecos River-style rock art's shaman-held staff motif as having a *Datura* seed at its distal end. The frequency of association between Lower Pecos *Datura* and canid rock art motifs increases with the appearance of the Red Linear-style during the Late Prehistoric (Boyd 2003:100).

The physiological effects of low dosages of *Datura* that ethnographers documented as producing behaviors remarkably similar to canid predators are detailed by Boyd (2003:95-99). This behavioral similarity underlies an accompanying belief in practitioners of lycanthrophy or human transformation into canid predators. The belief is often reinforced by tactile suggestions from animal skins worn by the person undergoing the drug-induced transformation (Boyd 2003:97-99). The long recognized connection between ethnographically documented shamanistic practice and Lower Pecos rock art is strengthened by the current study's results with its evidence for caping behaviors to produce predator skins that could be used as ritualistic paraphernalia.

Analysis, Interpretation, and Discussion of Feature 18 -- Paleoindian Bone Stacking or Just Plain Bull?

The carcass of a late Pleistocene bison is the final point to be discussed. Resting within the alluvial silts of stratum 40 in Pit D (N205/W167 unit) and beneath the inner edge of the "mother rock", these remains were designated as Feature 18 when initially discovered in 1967. In his field notes, Dibble (n.d.) fully believed the carcass to be affected by humans, although no obvious cultural associations, such as chert tools or debitage were found during the excavations. The remains also had no obvious butchering damage. Due to an impending hurricane, Feature 18 was reburied and excavated during the 1968 final field season. Although it was mapped, the excavators were not able to recover the exposed feature in its entirety due to the fragile nature of the water-saturated sediments and bone fragments. Two matrix blocks containing portions of the skull and four smaller groups of bone fragments were consolidated, jacketed, and removed for future analysis.

Following thorough museum preparation during the current research, the feature was analyzed over 30 years after its recovery from the site. Through careful laboratory examination, it was verified that the bone was water saturated at the time that the original consolidant was applied. The bone's internal moisture effectively prevented penetration of Gelva into the silty matrix or bone surface, resulting in a thin surface coating of consolidant on the bone and attached silty matrix. In the process of cleaning, this surface coating was carefully removed. This action revealed the surface of individual bone fragments for the first time, allowing their contents, integrity, and potential cultural modification to be assessed. In addition, the two jacketed matrix blocks were excavated under laboratory conditions. Concurrent analysis of field photographs allowed the author to determine that some of the lots containing appendicular bone included several elements and that the matrix blocks containing the skull had been removed in an anatomically flipped position.

Six lots of bone were field-cataloged upon their removal from the excavation unit and were available for the current analysis. Table 7.3 shows the contents of each of these lots.

Following museum preparation that revealed the anterior-posterior diameter of the right horn core base, the lateral edge of the orbit and the zygomatic arch were also exposed for examination and measurement that allowed identification of the species, age, and sex of the carcass. Figure 35 provides a composite view of Feature 18 that is based on the original mapping and photographs by the University of Texas field crew and the author's subsequent laboratory excavation of the matrix blocks containing the skull and analysis. The non-conventional orientation of map north in the figure enhances visual recognition of the feature's contents.

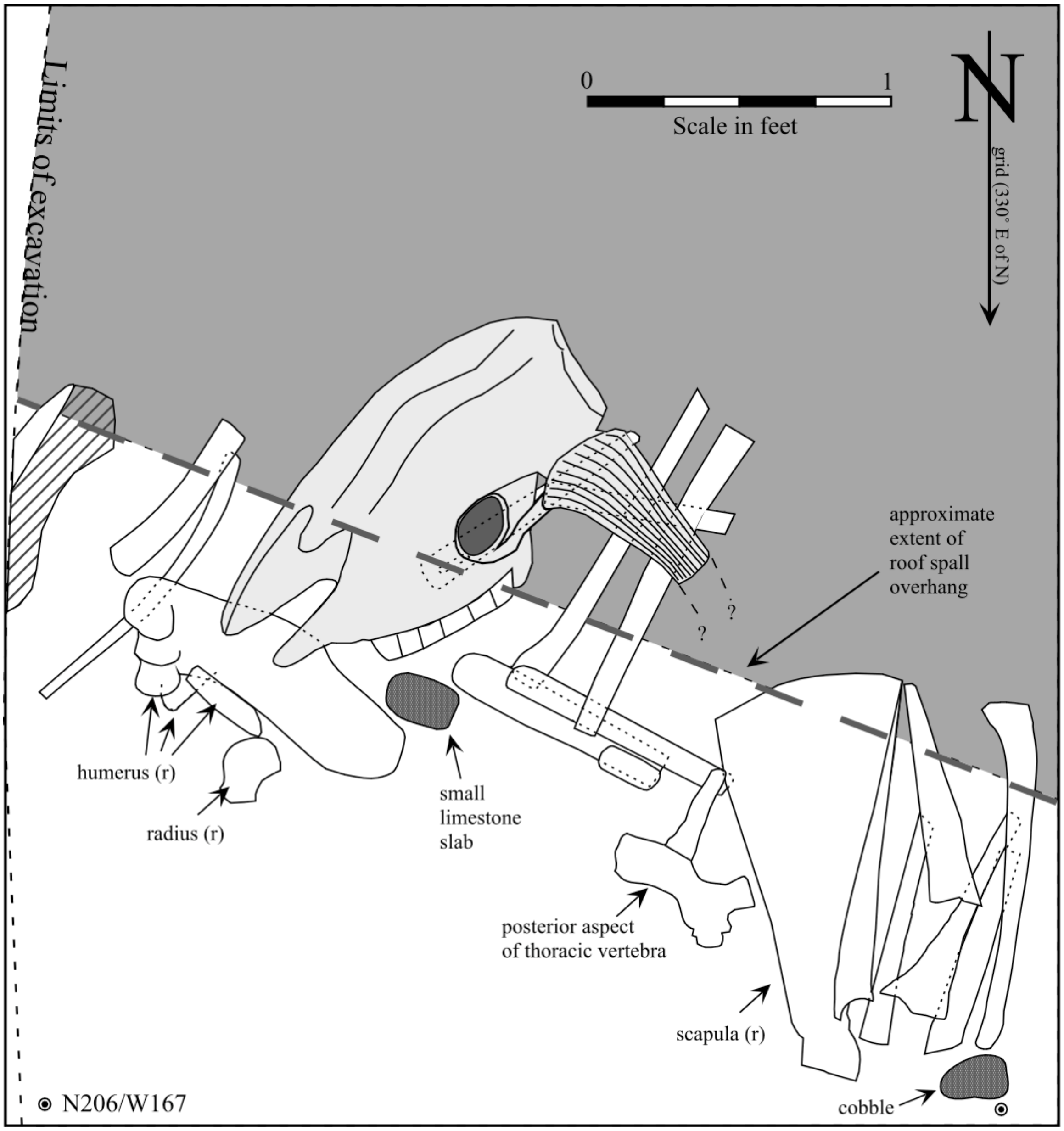

Figure 35: Composite View of Feature 18, Based on Original Excavations and Current Research.

Careful visual inspection of excavation photographs and sketch maps, a slow and thorough examination of Dibble's field notes, and the author's own current research documented that Feature 18 contains the anterior portion of a single bison carcass that was separated into two primary groups of bone approximately 1.5 linear feet apart. Two fragments of the right humerus, a fragment of the right radius, several ribs and thoracic vertebra spines, and the skull were clustered to the east of another group that included several rib fragments, a thoracic vertebra centrum, and the right scapula. The proximal diaphysis of the right humerus was absent, but the diaphysis and distal epiphysis were present in one large fragment. Elements identifiable in field photographs, but not collected by the field crew included the right scapula and an unspecified number of vertebral and rib fragments. No elements anatomically posterior to the thorax are evident either in the excavation photographs or in the physical collection. Whether this is due to the limited extent of the original excavation or the pre-burial condition of the carcass itself cannot be determined with the current data.

Using available sources of information, the carcass appears to have been disturbed prior to burial. The right scapula lies out of anatomical position to the left of the skull, separated from the fractured proximal end of the right humerus by a distance of 1.5 linear feet. The anterior portion of the skull rests on the distal end of the right humerus and points towards the back wall of the rock shelter, away from the river. In addition, the skull is resting on its palate with the left horn core tilted up at about a 30° angle. No evidence of the right horn core was noted in Dibble's field notes or faunal collection, although the conditions of excavation and recovery may have precluded the care in recognition, isolation, and consolidation that deteriorated, water-saturated bone demands. The brain case is fragmented, but present. Notably, neither mandible was documented during the excavation, nor were mandibular teeth were present in the faunal collection.

Compared with bone fragments contained in the underlying stratum 42, the bone contained in Feature 18 is more deteriorated physically. Causes of this deterioration originate both in pre-deposition weathering and the effects of possible groundwaterrelated diagenesis following its subsequent burial by deposition of stratum 39 and the overlying large roof spall or "mother rock".

Notable inclusions in Feature 18 are two limestone cobbles. Given that stratum 40B's largest other clasts are small gravels that are less than 0.5 inches in diameter, these cobbles are out of place in the otherwise sandy silt matrix of stratum 40B and silt drape of stratum 40A. The smaller cobble inclusion is globular in shape and about 2.5 inches in diameter. It was found near the west wall of the excavation unit in association with the bone cluster containing the right scapula. The other cobble was tabular in shape, approximately 1.0 inch thick, and 5.0 inches in diameter. The tabular cobble was found near the skull, adjacent to the proximal end of the right humerus. While no larger stone block was found associated with the recorded portions of the feature that might have functioned as an anvil, presence of the small cobbles is reminiscent of occurrences in Bone Bed 1 at Bonfire Shelter (Bement 1986; Dibble and Lorrain 1968).

Taken as a whole, the deteriorated remains recorded as Feature 18 during the Arenosa Shelter excavations represent portions of the anterior half of a single disturbed extinct bison carcass. Using the teeth present in the upper tooth row and a relative position for the frontal suture, analysis and interpretation of the feature centered on skull fragment measurements that allowed comparison with known age, sex, and species of extinct Terminal Pleistocene – Early Holocene taxa of bison and their modern replacements to determine the age, sex, and species of the bison from Feature 18. Given that the relative position of frontal suture position used is a rough estimate only and is most likely placed too far laterally, the resulting measurements are in fact smaller than actual for specific characters being measured. The physical measurements of the cranium from Feature 18 were compared with relevant published data for Southern Plains modern and extinct Late Pleistocene – Holocene bison, including *Bison antiquus antiquus*, *Bison* *antiquus occidentalis*, and *Bison bison* from McDonald (1981), Skinner and Kaisen (1947), and Wilson (1974, 1975) and are presented in Table 7.4.

Measurements that were chosen for comparison with known taxa include those for

1) total length of the maxillary molar portion of the tooth row,
2) width of the upper first molar,
3) skull width at the orbit and immediately posterior to the orbit,
4) basal antero-postero diameter of the horn core,
5) angle of divergence of the horn core forward from the sagital plane, and
6) direction of origin of the horn core from the frontal bone.

Some of the anatomical measurements for Feature 18 in Table 7.4 are less than half of what they were in life because only one side was available for measurement and the frontal suture position is roughly estimated, most likely resulting in a underestimation of the actual measurement.

Compared with cranial characteristics for both sexes of the three Late Pleistocene – Holocene Southern Plains *Bison*, the Arenosa Shelter Feature 18 specimen was between 3.5 and 4.5 years of age at death, based on tooth eruption and wear characteristics for Southern Plains bison (Guthrie 1990; McDonald 1981; Skinner and Kaisen 1947; Wilson 1974, 1975; Wyckoff and Dalquest 1997). While all three of the maxillary molars are erupted, the M^1 is heavily worn, the M^2 is moderately worn, and the M^3 is unworn. This represents a fall to winter season of mortality.

The Feature 18 bison carcass most closely resembles the male *Bison antiquus antiquus* on the basis of composite horn core characteristics. Specifically, these characteristics include the horn core's virtually perpendicular angle of divergence forward from the sagital plane (86°), its subhorizontal exit from the frontal, and its relatively large antero-postero basal diameter (104 mm). Given these combined physical characteristics, Feature 18 most likely represents the disturbed, partial carcass of a young adult male *B. a. antiquus*.

A review of the physical evidence is useful. Portions of the carcass's right forelimb were present, but disarticulated and spread across a distance of several feet. After careful cleaning and museum preparation, no obvious cutmarks were found on these or other fragments present because the bone surface was too deteriorated. Reiterating Lyman's (1994a:306) caution about the absence of butchering damage at any particular anatomical location, positive evidence of surface alteration by other means correlates only to absence of butchering damage, not to negative evidence for it. Although the carcass was not in original anatomical position, only two of the bone fragments examined had minor tooth marking from carnivores or scavengers. Significantly, these tooth-marked fragments were a rib fragment and thoracic vertebra spine that were found *in situ* beneath the hard palate of the maxillary portion of the skull. The other cranial, axial, or appendicular skeletal fragments do not retain any evidence of carnivore modification. None of the available fragments have evidence of feeding by the large carnivores or scavengers that were present in the Late Pleistocene. The minor carnivore activities associated with the carcass are best explained by the furtive activities of smaller scavengers prior to movement of the skull to overlying the affected bone fragments. The humerus was unattractive to carnivores in search of marrow if first broken by humans who removed the marrow (cf. Marean and Bertino 1994:765).

Hill (1979a:742-744; Hill and Behrensmeyer 1985) compared the natural disarticulation sequence and butchering evidence for extinct bison at the Olsen-Chubbuck Paleoindian site. He found little difference between the naturally occurring sequence and dismemberment that accompanies intensive butchering because both processes exploit weaknesses in articulations found throughout the body. One of the illustrations that he used is telling because the degree of disarticulation or dismemberment exhibited by Arenosa Shelter's Feature 18 bison carcass is relatively advanced (Hill 1979a:Figure 2).

How should the disarticulated forelimb of this carcass and associated cobbles be interpreted? Given its position below strata that have an absolute date within the Paleoindian period, can this feature be considered the results of a kill or scavenging of a relatively fresh carcass by Paleoindians? The degree of disarticulation in Feature 18 does not fit the cold-season pattern of minimal disarticulation of fresh bison kills seen farther north on the Plains, but is closer to the greater disarticulation seen in warm season kills (Todd, *et al*. 1990:821). While it is difficult to determine whether articulated portions of the axial skeleton were removed as a unit, the recognition of portions of thoracic vertebrae in the elements present make this unlikely. Rogers and Martin (1984:761) re-examined the 12 Mile Creek Clovis site in Kansas and found that when bison skulls were not removed from a Paleoindian kill area for further processing elsewhere or totally fragmented in place, they may be moved a relatively short distance.

Bement (1999) notes a difference between the intense butchering of small kills and less intense butchering with large kills during the Folsom period, at least operable farther north on the Central and Southern Plains. From evidence in the Lower Pecos's Bonfire Shelter, the dichotomy in butchering intensity may not have been operable in the Lower Pecos. Bonfire's Paleoindian period Bone Beds 1 and 2 show evidence of intensive primary butchering that involved virtually complete dismemberment of bison carcasses, intensive processing of skull units to obtain the contents of the brain case, tongues, and other desirable products, stacking of like elements in the same areas, and marrow retrieval after fragmentation of appropriate elements (Dibble and Lorrain 1968; Lorrain 1965). Notably, Bonfire Shelter excavator Dibble (Dibble and Lorrain 1968) also found what he and later investigator Bement (1986) interpreted as butchering blocks or stone anvils, cobbles, and evidence of articulations that had been battered apart in the lower portion of Bone Bed 2 and in underlying Bone Bed 1.

At this point in the discussion, it is useful to remember that Dibble (n.d.) defined stratum 40 as a low-energy flood deposit that contained no inclusions larger than small gravels. The bison carcass in Arenosa Shelter's Feature 18 was associated with two limestone cobbles. Dibble (n.d.) noted that these cobbles were out of place in the fine sediments of stratum 40. The limited extent of excavation associated with this feature hinders interpretation of the extent of processing associated with its young bison bull carcass. The small area excavated under the "Mother Rock" did not reveal the presence of the remainder of the carcass or a stone anvil/butchering block. However, the unexplained presence of the cobbles in stratum 40, degree of dismemberment of the carcass, and fragmentation of the right humerus are suggestive of evidence for disarticulation using battering during butchering found in Paleoindian context in Bonfire Shelter's lower levels, although the Arenosa Shelter cranium was not damaged to the same extent. It is also suggestive of deliberate human bone fragmentation for marrow removal (Marean and Bertino 1994).

At best, the proof for Paleoindian involvement with Feature 18 is moderately convincing to corroborate Dibble's (n.d.) belief that this young bull was butchered or scavenged by humans. Using available indirect evidence in the absence of direct evidence that more complete excavations at this level would have provided leaves potential interpretation of this feature incomplete. However, the position of the bull's skull overlying other elements that were minimally carnivore ravaged, fragmentation of the humerus, and suggestions of bone processing similarities to the earliest levels at Bonfire Shelter partially lend credence to Dibble's (n.d.) belief that Feature 18 represents an episode of cultural modification of a freshly killed animal through butchering or through scavenging of its bone, sinews, and fat sources.

Chapter 8: Summary and Conclusions

In summarizing the current research to, the full extent of data recovered from Arenosa Shelter should be considered. The Arenosa Shelter collections do not contain as complete an inventory of perishable material culture as drier rock shelter sites in the region. However, they do provide a unique view into inter-related technological subsystems present prehistorically in the Lower Pecos region. The faunal component of subsistence data for the site extends into Paleoindian context and forms the foundation upon which the bone technology is based. Flood damage in the lower Archaic cultural deposits winnowed the deposits. The impact of these recurrent catastrophic floods removed the record of bone technology from Early Archaic deposits at Arenosa Shelter. A firm understanding of bone technology for Middle Archaic and later contexts is possible because they are well represented in Arenosa Shelter's lengthy stratigraphic record.

SUMMARY

The rich faunal record contained in Arenosa Shelter's deep, stratified deposits contains over 47,000 specimens collected during the 1965–68 excavations, including many bone artifacts. The current research examined a 10.4 per cent sample of faunal materials from more precisely controlled excavations that had the best bone preservation and deepest stratigraphy in the site. Although biased by a recovery strategy that excluded most of the smaller faunal remains, the current research yielded remains of over 140 vertebrate taxa. Taxonomic assignments included 12 to class only, ten to order, 12 to family, 33 to genus, 65 to species, and two to sub-species.

While the range of taxa present in the site's faunal assemblage was diverse, several more narrow segments dominated it. The NISP frequency was highest for lagomorphs, large mammals that were nearly all deer or pronghorn, and medium to large fish. Lagomorph frequency was greatest from Late Archaic to Historic context, although large mammals were an important component throughout the sequence. Lagomorphs were important in subsequent technological pursuits wherever present. Large mammals were the most numerous Paleoindian constituents and were largely in the horse or bison size range. Large mammals in later contexts were in the deer or pronghorn size range and were also incorporated into technological activities.

The high relative frequency of the two leporid genera indicates that Lower Pecos hunters and gatherers during the Late Archaic to Historic periods utilized a wide swath of the landscape, from the riparian canyons to upland desert grasslands. MNI/MNE counts are similar, although medium body-size mammals including carnivores and large rodents are also a more frequent constituent of the total Late Archaic and Historic – Late Prehistoric subsistence remains than evident if frequency is based solely on a NISP measure. During and after the Late Archaic, large fish become an important part of the subsistence economy, especially gar, catfish and cypriniform suckers. Importantly, although they were never as numerous as mammals in the faunal remains, large birds were present and included geese, ducks, broad-winged hawks, turkeys, roadrunners, and gulls. Hawk bone was important in subsequent prehistoric technological activities. The remains of dabbling ducks seasonally present in the canyons corroborate the episodic presence of deep pools along the Pecos and Rio Grande that are suggested by the frequent presence of blue catfish remains. Small birds included kites and small hawks, doves, and quail, which was the most numerous of these smaller avian forms.

Age classes and sex were recorded in the limited cases where appropriate. Well over 87 per cent of the faunal sample was considered to represent adult individuals. Approximately 5 per cent of the sample was juvenile, about 7 per cent was subadult, and the remainder were old individuals. Cottontail rabbits were the most frequent juvenile form, although jackrabbits and canids also being moderately common. Juvenile deer were poorly represented in the faunal remains recovered from the site. Subadult rabbits are also very common, with cottontails being about six times more numerous than jackrabbits. Subadult gray foxes are the most frequent of the medium mammals. Subadult deer are slightly more common than subadult jackrabbits. Raccoons were the most common old mammals, with deer, woodrat, white-throated woodrat, beaver, and rock squirrel also being represented in this age group. Cottontail rabbits are the most common adults. Jackrabbits and deer are less common, but still numerous. Adult domestic sheep or goat, modern bison, Pleistocene bison, pronghorn, and an extinct Pleistocene large deer were present. Differentiation between sexes was possible in only a few cases. An extinct bison bull was present in Paleoindian context, adult deer remains were identified in all contexts later than Middle Archaic, and an old male beaver was identified in Historic – Late Prehistoric context.

Culturally modified faunal specimens in the faunal sample totaled about 11 per cent, with changes induced by cooking or butchering, *sensu* Binford (1981b). A wide variety of taxa were included: fish, birds, turtles, and of course, mammals. Remains of large and medium mammals had more cultural modifications than those of small mammals. Only rock squirrels among small mammals had butchering damage.

Modified medium mammals included rabbits, beaver, and most carnivores, except the skunks. Modifications included recognizable skinning behaviors affecting the regions of the extremities and head. Specialized skinning behavior evidence was present among carnivore remains in Terminal Late Archaic contexts, but was also seen in a Late Archaic rabbit specimen. The combination of patterned burning damage and recognizable meat stripping among rabbit remains points to the practice of secondary butchering following cooking. Importantly, cottontail extremities do not appear to have been disarticulated by cutting in the same manner as jackrabbits and other medium-sized mammals.

Culturally modified large mammals included deer, bison, pronghorn, and sheep or goat. Heat damage is common, as is butchering damage or human-induced fracturing for marrow recovery, bone grease production, or the initial stages of subsequent technological modification. Skinning, dismemberment, and meat stripping damage is common in specimens of Middle Archaic or later context. Modification included scraping to remove the periosteal membrane covering appendicular elements.

Non-mammalian specimens in the sample were also culturally modified. Quail, hawk, and diving duck specimens exhibit burning damage, cooking damage, or dismemberment and defleshing cutmarks. At least one red-shouldered hawk specimen has been technologically modified in the manner that would result in bone bead production. Burning or dismembering cutmarks modified turtle carapace and appendicular fragments. Fish remains were modified by either burning or by cutmarks that indicate butchering or subsequent tool manufacture. While previously undocumented from the region, the current research has resulted documented specific signatures on fish vertebrae that point to specific filleting behaviors in human processing. Other specific, but previously undocumented, butchering damage recorded specific methods of safely handling catfish. Cutmarks at the base of the pectoral spines in a position to sever the musculature of the articulation with the body document a disarming method to defeat the defensive spines.

Fragments that had been modified beyond the normal limit for butchering or marrow retrieval were a common occurrence during the faunal analysis. In some cases, the fragments were recognized as implement fragments or debris from the implement or ornament manufacturing process that had not been cataloged. Recognition of such technological modification set the stage for analysis of bone artifacts in the second phase of the current research.

The research's second phase analysis was of a large sample of the site's technologically modified faunal remains. Approximately 55 percent of the cataloged bone artifacts were analyzed to determine manufacturing and use wear characteristics.

Importantly, the analysis followed an exacting museum preparation effort that exposed the surfaces of these artifacts for analysis, many for the first time. In the process of microscopic examination during the preparation work, it was recognized that many of the fragmentary tools and ornaments had significant amounts of surface modification. The research design was expanded to include microscopic analysis of manufacturing and use wear characteristics for the sample at magnifications of 10x – 70x. Also recognized during museum preparation were manufacturing byproducts that indicated the presence of a process of manufacturing for both tools and ornaments. This important point in the research's second phase allowed documentation of parallels to existing lithic technology processes.

Two classes of bone artifacts were recognized in the collection sample, implements and ornaments. While the implement class was determined to have two approaches to blanks preparation during the manufacturing process, both classes shared subsequent steps in the process. Recognition of this commonality led to understanding an underlying strategy for raw material manipulation operable in bone technology.

Insight was gained into source animals used for implement and ornament forms. Byproducts discarded from the manufacturing process retained anatomical features that were identifiable to taxa, sometimes to genus or species level. This material was considered to be debitage. When combined with manufacturing failures, it assisted in understanding some of the decisions made by prehistoric technologists. Importantly, while raw material for many of the undecorated beads was obtained from rabbit bone, other major sources included long bones from hawks and mammalian carnivores that are less frequent in the subsistence debris. The sources for bone tubes were also often identifiable because minimal manufacturing modification left remnant anatomical features identifiable to taxon.

Using the methods of Lemoine (1997) to determine manufacturing and use wear signatures, a probable tool kit and sequence of manufacture were developed for both ornaments and implements. These included cutting implements produced by the region's lithic technologists and tools used to produce lithic tools.

One of the primary methods of manipulating osteological raw material was by cutting grooves with chert tools, sometimes accompanied by snapping apart the element to separate portions that had been cut. The snapping procedure induced torsional or perpendicularly applied forces in the element to remove the blank from its debitage. Further steps potentially involved scraping with a chert tool. The scraping step had two possible results, a) the periosteal membrane was removed from the surface allowing easier access to the underlying bone, or b) the bone surface or surface of grooves that had just been cut were further shaped. Grinding was often then used to achieve a final configuration to the item being manufactured, including a) removal of unwanted portions of the item (e.g. remnant articulations), b) edge or tip shaping, or c) creation of functional or decorative facets. For implements not using this approach to raw material manipulation, the byproducts of subsistence activity-related marrow retrieval provided a ready source for raw material that could be shaped further using the above methods or using dynamic methods more akin to lithic technology. Percussion flaking was used for some tool forms to shape them. Most implements were manufactured from large mammal bone originating from subsistence activities. Much of the large mammal bone was identifiable as artiodactyl metapodia.

Microscopic examination of surface characteristics on the bone artifacts resulted in recognition of wear patterns from prehistoric use. These consisted of striations of varying widths, depths, configurations, and orientations; surface polishes and rounding; and presence or absence of the bone's structural features (osteons) at the surface. Given a broad range of possibilities documented in the current bone tool use wear literature, wear on bone implements and ornaments in the Lower Pecos exhibited a narrower array of uses. These involved contact between the bone artifact and several materials, including silica-rich plants, wood, meat, fresh hide, hide with hair, dry hide, and siliceous stone. Using morphological and use wear characteristics in tandem, uses for implements included:

1. wood-working,
2. flint knapping,
3. stripping of bark from shrubs and small trees,
4. fiber stripping from desert succulents,
5. pressure and soft hammer percussion flaking in flint knapping,
6. meat cutting and butchering,
7. fresh hide dressing,
8. perforating hides or bundles of plant fiber textiles, and
9. sewing of sinew or plant fiber cordage.

Use-wear for bead forms indicates that they were sometimes strung on plant fiber cordage, sometimes on sinew, and occasionally sewn onto hides or silica-rich plant fiber textiles as surface decorations.

CONCLUSIONS

The current research documented the outcome of subsistence and technological activities that occurred when indigenous inhabitants congregated along the river. Archaic, Late Prehistoric, and Historic period residues from Arenosa Shelter contain results of their attempts to hunt, fish, trap, gather plants for food and fiber, create implements and ornaments, and fulfill many of their other daily needs including rituals.

Zooarchaeological Research

Gathering at the river is an important component in a broader landscape use that is documented by the current zooarchaeological research. Use of additional components of the Lower Pecos landscape is also documented by the current research. A much broader use of the Lower Pecos environs, especially the uplands, was evident from research results.

Zooarchaeological Research Conclusion #1: Lower Pecos residents used much of the landscape in obtaining the faunal portion of their subsistence economy.

A conclusion that the Arenosa Shelter residents used much of the Lower Pecos landscape is strongly supported by the results of this study. Many of the animal taxa are not denizens of the canyons, but inhabit the rocky upland slopes and rolling arid plains of the uplands themselves. Only in the human habitation areas of the Lower Pecos do the upland jackrabbits and blue catfish of the deep river pools mix together to enter the larder, decorative arts, and tool kits of the hunters and gatherers.

Zooarchaeological Research Conclusion #2: Lower Pecos indigenous residents made full use of faunal resources from the canyons and surrounding arid uplands, fully processing carcasses for food and other products.

If the prehistoric Lower Pecos residents gathered at the river, how did they use the faunal resources obtained in the canyons and surrounding landscape? From the zooarchaeological segment of the current research, the conclusion is drawn that prehistoric hunters and gatherers from the Paleoindian period onward took large and small animals as prey. Human residents of the Lower Pecos canyon lands processed the prey carcasses for the meat, fat, connective tissues, hide, bone, and other products offered by them. Although the evidence for Paleoindian use of faunal resources in the vicinity of Arenosa shelter is scanty and potentially enigmatic, there is evidence of butchering and processing for marrow retrieval. The stratigraphic sequence at Arenosa Shelter dating to the Early Archaic is badly affected by the effects of catastrophic flooding that winnowed out most faunal remains or removed them altogether, but burned bone indicates presence of human inhabitants making use of faunal resources in the shelter. The stratigraphic sequence dating to the Middle Archaic and later reveals a much better case for aspects of the subsistence system operating in the canyon lands.

Zooarchaeological Research Conclusion #3: Prehistoric Lower Pecos indigenous inhabitants tapped the resources of the rivers and fully used the available fish for subsistence and technological purposes.

Conclusive evidence is present in the Arenosa Shelter record for precise processing strategies for removing the flesh from fish and safe handling of catfish that were caught. Patterning in cutmarks present on axial skeletal material of fish indicates filleting of flesh from the carcasses of medium to large fish. The use of this technique raises the possibility that residents were drying or otherwise preserving the fillets. With the arid regional climatic conditions, dry locations protected from weather, and the products of the textile technological subsystem, the possibility of transport of products from fish out of the canyons themselves should not be discounted. Fish filleted, preserved as a staple for long-term storage, and moved elsewhere in the landscape for storage and use is a distinct possibility that has not been considered before. The results of prehistoric decisions concerning safe handling of catfish between capture and butchering are conclusively revealed in specific patterning of cutmarks on pectoral spines from the site. The ability to safely control and manipulate the bodies of these very muscular fish following capture was a benefit that allowed full benefit to be obtained from the food and other products that they represented. Large catfish could exceed a weight of 100 pounds and seriously injure a careless human handling them. The prehistoric discovery of a procedure to disarm the locking mechanism for the defensive spines by cutting the controlling musculature must have been important and one that enhanced the proceeds of the rivers' bounty.

Zooarchaeological Research Conclusion #4: Lower Pecos indigenous peoples used specific techniques, such as caping, to skin medium sized mammals for purposes other than standard subsistence needs.

Conclusive evidence is also present that documents a skinning method used by hunters to remove whole pelts of mammalian carnivores. Similar methods were used elsewhere on the Plains to produce fetishes and shamanistic paraphernalia from the hides of birds and small to medium-sized mammalian carnivores. Connections are present between these skinning methods with the potential of their products to be used as fetishes or shamanistic paraphernalia, ethnographic evidence for use of such skins as paraphernalia in rituals using hallucinogenic plants found in the region paleobotanical record, and motifs in the region's rock art showing use of such paraphernalia ritually.

Zooarchaeological Research Conclusion #5: By the Middle Archaic, Lower Pecos indigenous peoples used faunal resources for purposes beyond fulfilling subsistence needs, incorporating their byproducts to fulfill technological needs.

The Lower Pecos residents incorporated faunal subsistence byproducts into their technological systems by the Middle Archaic. Taking a portion of the region's subsistence bounty as raw material for a technological subsystem provided an alternative for scarce durable raw materials, such as hardwood, and allowed further development of lithic and textile technological subsystems.

Bone Technology Research

The bone technology segment of the research results allows conclusions to be drawn about raw material choices, processing methods, and use of bone technology to support or enhance other technological subsystems during the Archaic, Late Prehistoric, and Historic periods. These will be considered on the basis of provisional interpretations from the current research.

Bone Technology Research Conclusion #1: Prehistoric Lower Pecos indigenous inhabitants tapped the byproducts of subsistence in specific ways for raw materials that were incorporated into the technological subsystem.

A conclusion from the bone technology portion of the current research can be deduced prehistoric choices about raw material sources. Choices were documented in the research about which raw materials were obtained for technological purposes from subsistence residues and how they were processed. Fortuitous presence of debitage and completed artifacts retaining anatomical features allowed source animals for raw materials to be identified for several of the ornament and implement forms to be determined with a greater degree of certainty in the current research than previous researchers had achieved. The identification of source animals allowed a conclusion that

Lower Pecos residents used a diverse range of animals as raw materials in the manufacture of ornaments. Beyond frequent rabbit remains, the current research concluded that hawk, mammalian carnivore, and artiodactyl bone and antler were used as raw materials for bead forms.

As with ornaments, prehistoric choices about raw materials for specific implement forms can be deduced from the implements themselves, their debitage, and other manufacturing byproducts. Smaller implement forms used medium-sized mammal bone or catfish spines in some cases. This possibly represented a decision to reduce the labor input required to create a similar, more durable form from artiodactyl elements. Raw material for most forms was obtained from only a few artiodactyl appendicular elements centering on dense lower leg bones. Manufacturing techniques for artiodactyl metapodia-based implement forms were extensive and labor intensive. Refitting or tool rejuvenation was practiced where breakage during manufacturing or use resulted in a usable fragment of a tool.

Bone Technology Research Conclusion #2: Prehistoric Lower Pecos inhabitants incorporated decorative elements into technological pursuits.

Conclusions are also allowed about the manner that the bone technology subsystem took products from the subsistence process and created decorated ornaments and implements. Employing simple linear motifs that vaguely mirror the rich and long-lived multimedia artistic traditions of the Lower Pecos, subsistence residues were modified into atypical implements and ornaments. While most forms analyzed during the current study are unadorned by decorative elements, several bead and spatulate forms have parallel or cross-hatch decorative motifs incised into their surfaces. Use wear studies reveal that these implements and ornaments were fully functional with the sort of wear resulting from uses typically found on undecorated forms.

Bone Technology Research Conclusion #3: Residents of the Lower Pecos region used bone technology for the purposes of supporting other segments of the overall technological system.

The current research results also allow conclusions about how the bone technology subsystem created implements to support other technological subsystems directly and indirectly. The bone technology subsystem enhanced subsystems for lithic technology, textile technology, and subsistence technology as a whole. The results of use wear analysis revealed that certain implement forms were used to obtain and process bark and plant fibers. The bone technological subsystem functioned in this case in a role to support the textile technological subsystem in obtaining and processing raw materials to create woven or twined textiles, including cordage, matting, and other items. Other implements aided in specific steps of the flint knapping process used by the lithic technology subsystem to create cutting tools and armaments used for hunting, gathering, and defensive purposes. Subsistence technology itself was aided by use of products from the bone technology subsystem in the butchering process and in processing hides for future use, with expedient and formal implements both being used in subsistence pursuits.

The final inter-related system affected by bone technology must be the religious belief system of the Lower Pecos inhabitants. Best illustrated by the rock art still prominent in the region, the belief system apparently used bloodletting in its rituals due to inclusion of items with blood residues on them in dry cave caches. The potential ritual uses for the catfish spines that so much care was used in obtaining must not be underestimated. The relationship between the caping evidence from this study, ethnographic evidence for use of hallucinogenic plants, and the religious beliefs evident in the Lower Pecos region's rock art are intriguing. They support potential outcomes as shamanistic paraphernalia for this particular skinning behavior. The ritual linkage between the manufacture of bead forms and specific source animals such as the hawk, mammalian carnivore, deer, or all-important rabbit should also not be ignored.

Further Research

The current research represents an initial foray into aspects of zooarchaeology and bone technology studies that have never been attempted in this region. Further research might allow the following issues to be more fully investigated.

The possibility that filleted fish were preserved as a staple for long-term storage and moved elsewhere in the landscape for storage and use is a distinct possibility that has not been considered until the current research. Sites with a better Early Archaic record, such as Baker Cave and Hinds Cave, are available for study using existing museum collections as follow-up research to fill any information gaps based on Arenosa Shelter conclusions. Use of these collections would eliminate the time gaps in the Arenosa Shelter-based record. It would also allow differences in prehistoric use of the river and adjacent landscape between the Pecos, Rio Grande, and Devils River drainage portions of the region to be explored using such data.

Appendix 1

Table 2.1: Regional Cultural Chronology (After Turpin 1991).

Period Name (after Dibble)	**Nominal Culture Stage**	**Dates (in years B.P.)**	**Associations (projectile points and other diagnostic cultural materials)**
Historic	Historic	250 - modern	historic artifacts and rock art with Spanish Colonial or Euro-American elements included
Infierno	Late Prehistoric	450 - 250	stemmed arrow points, beveled end scrapers, prismatic blades, plain brownware and bone-tempered ceramics, stone circles
Flecha	Late Prehistoric	1,320 - 450	arrow points, *Ensor*, cairn burials, ring middens (?), Red Linear rock art style
Blue Hills	Late Archaic	2,300 - 1,300	*Ensor, Frio, Shumla*, bundle burials
Flanders	Late Archaic	2,300 (?)	*Shumla*
Cibola	Late Archaic	3,150 - 2,300	*Montell, Marshall, Castroville, Marcos,* butchered *Bison bison* remains
San Felipe	Middle Archaic	4,100 - 3,200	*Langtry, Val Verde, Arenosa, Almagre*, Pecos River rock art style
Eagle Nest	Middle Archaic	5,500 - 4,100	*Pandale*

Period Name (after Dibble)	**Nominal Culture Stage**	**Dates (in years B.P.)**	**Associations (projectile points and other diagnostic cultural materials)**
Viejo	Early Archaic	8,800 - 5,500	Early Barbed- and Early Triangular-style, *Baker, Bandy*, burned rock middens
Oriente	Late Paleoindian	9,400 - 8,800	*Golondrina, Angostura*
Bonfire	Paleoindian	10,700 - 9,800	*Folsom, Plainview*, butchering debris of extinct megafauna
Aurora	Paleoindian	14,500 - 11,900	*Clovis*, butchering debris of extinct megafauna

Table 2.2: Dates of ^{14}C Assays from Arenosa Shelter and Their Proveniences.

#	**Age (not MASCA corrected)**	**Laboratory Identification Number**	**Stratum and Cultural Associations (Projectile Point Styles, etc.)**	**Material Dated**	**Reference (*Radiocarbon Journal* denoted as *RC*)**
1	1380±60	TX661	2a; Ensor, arrow points	charcoal	*RC* 12(1); Patton and Dibble 1982
2	1910±70	TX537	5; *Ensor, Frio*	charcoal	*RC* 12(1); Patton and Dibble 1982
3	1970±110	TX284	7 (Surface of Hearth); *Ensor, Frio*	charcoal	*RC* 9, Dibble 1967; Patton and Dibble 1982

#	Age (not MASCA corrected)	Laboratory Identification Number	Stratum and Cultural Associations (Projectile Point Styles, etc.)	Material Dated	Reference (*Radiocarbon Journal* denoted as *RC*)
4	2070±140	TX285	9 (Lower); *Marcos, Shumla, Frio*	charcoal	*RC* 9, Dibble 1967
5	2130±105	SI1394	5; basal	charcoal	Dibble 1967
6	2150±80	TX536	7; basal *Ensor, Frio*	charcoal	*RC* 12(1); Dibble 1967
7	2165±70	SI1395	7; general	charcoal	Dibble 1967
8	2230±80	TX696	9 (Upper); early *Ensor, Frio*	charcoal	*RC* 12(2); Patton and Dibble 1982
9	2410±140	TX286	11 (Upper); *Montell*	charcoal	*RC* 9, Dibble 1967; Patton and Dibble 1982
10	2440±140	TX311	11(Lower); *Montell*	charcoal	*RC* 9, Dibble 1967; Patton and Dibble 1982
11	2520±50	TX1977	11; *Montell*	charcoal	*RC* 19(2); Dibble 1967
12	2540±75	SI1397	10, general	charcoal	Dibble 1967
13	2785±75	SI1396	9, basal	charcoal	Dibble 1967
14	3220±70	TX701	21; *Langtry, Val Verde*	charcoal	*RC* 12(1); Patton and Dibble 1982
15	3350±85	SI1403	22C	charcoal	Patton and Dibble 1982

#	Age (not MASCA corrected)	Laboratory Identification Number	Stratum and Cultural Associations (Projectile Point Styles, etc.)	Material Dated	Reference (*Radiocarbon Journal* denoted as *RC*)
16	3600±70	TX1975	23; *Val Verde, Langtry, Almagre*	charcoal	*RC* 19(2); Patton and Dibble 1982
17	3640±80	TX662	22X; hearth, *Langtry*	charcoal	*RC* 12(1); Patton and Dibble 1982
18	3875±55	SI1402	25; general	charcoal	Dibble 1967
19	3985±100	SI1400	25B	charcoal	Dibble 1967
20	4080±380	TX287	Upper 23D; *Langtry, Val Verde, Almagre*	charcoal	*RC* 9; Dibble 1967
21	4150±150	TX324	23D; *Pandale, Almagre, Val Verde*	charcoal	*RC* 9; Dibble 1967; Patton and Dibble 1982
22	4430±80	TX538	25A (Surface); hearth, *Pandale*	charcoal	*RC* 12(1); Patton and Dibble 1982
23	4440±110	TX660	30A; *Pandale* (possibly contaminated)	charcoal	*RC* 12(1)
24	4450±150	TX1979	28; hearth, *Pandale*	charcoal	*RC* 19(2); Patton and Dibble 1982
25	4465±110	SI1399	23b	charcoal	Dibble 1967

#	Age (not MASCA corrected)	Laboratory Identification Number	Stratum and Cultural Associations (Projectile Point Styles, etc.)	Material Dated	Reference (*Radiocarbon Journal* denoted as *RC*)
26	4630±100	SI1401	28; hearth	charcoal	*RC* 19(2) comments; Dibble 1967
27	4670±70	TX773	30; Lowest *Pandale*	charcoal	*RC* 12(2); Patton and Dibble 1982
28	4685±100	SI1398	21; general	charcoal	Dibble 1967
29	4790±140	TX312	25; *Pandale*	charcoal	*RC* 9; Dibble 1967
30	5360±170	TX313	32 and lower; Early Barbed Series	charcoal	*RC* 9; Dibble 1967 Patton and Dibble 1982
31	5520±280	TX1976	28; *Pandale*	charcoal	*RC* 19(2); Dibble 1967
32	9550±190	TX668	38; below Early Barbed Series	charcoal	*RC* 12(1); Patton and Dibble 1982

Table 2.3: Description of Arenosa Shelter's Upper Strata after Dibble (n.d., 1967) and Collins (1974).

Stratum	Description
1	thick (4.0 ft) layer of loosely compacted, unstructured humus rich tan sand containing noticeable quantities of decaying organic matter, deposited by the major 1954 flood during Hurricane Alice.
2	thick (2.0 ft) semi-compacted light brown sand, with abundance of prehistoric cultural materials throughout, with scattering of historic artifacts in upper surface. Level and continuous within shelter, truncated by erosion towards river. Prehistoric material included arrow points, dart points, shell, limestone spalls, and burned rock.
3	thick (3.2 ft), compacted light gray to medium brown sand with high percentage of ash, burned rock, bone, mussel and snail shells, and lithic waste in several distinct lenses towards rear of shelter.
4	thin (0.5 ft), loosely compacted light to medium brown sand with a thin scattering of chipped stone cultural materials and sparse burned rock forming discontinuous separation between strata 3 and 5.
5	thick (2.8 ft), loose light to dark gray sand with abundant cultural materials, especially burned rocks, shell, limestone spalls, charcoal, ash, and lithic tools and waste, also contains abundant mammal and fish bones.
6	Thin (1.1 ft), light orange aeolian sand within the shelter, apparently sterile and originating from alluvial deposits on the former floodplain surface below the shelter.
6a	thin (1.5 ft), sterile sand, apparently aeolian in origin, but modified by runoff to include graded laminae, located on terrace outside of shelter.
7	thin (<1.1 ft) grayish sand with abundant ash, and charcoal burned rock, shell, lithic artifacts, and lithic waste. Ash noted in field notes as probably originating in unlined hearths.
8	thick (max. 2.8 ft) reddish-tan sand with sparse charcoal and shell, thinner or absent in shelter and thickest on downstream terrace, apparently redeposited.

Stratum	Description
9	thickest (max. 5.3 ft) stratum in site, light gray to dark gray-brown sand, internally separated by thin compact layers of sterile tan silt on downslope edges where stratum was thickest. Stratum 9 contained high percentage of burned rock, limestone spalls, charcoal, ash, shell, lithic artifacts, and bone.
10	thin (0.1 - >1.0 ft) semi-compacted tan sand similar to Stratum 9 but light in color and less rocky, separated from Stratum 9 on by compact thin layer of sterile silt on downstream end of site.
11	moderately thick (1.0 - 2.3 ft) light gray to dark gray brown sand, similar in character to Stratum 9.
12 - 18	a series of seven very thin (0.1 ft) strata that included four with sterile silt or sand (strata 12, 13, 15, 17) separating three (14, 16, 18) with at least some cultural materials. They were recorded and removed as a single unit, although they could be separated into individual strata in the downstream exposure.
19	a virtually sterile extensive reddish tan sand of variable compactness. Apparently deposited as fill in a drainage channel that paralleled the back wall of the shelter, it slopes sharply downward and widens to the west and forms the deepest stratum encountered in the downstream part of the excavations.
20	a thin (1.0 ft) dense fine-grained light reddish tan silt at the base of the (stratum 19) channel fill. The channel cut through a number of lower strata in the central part of the shelter. Stratum 20 contains at least some cultural materials, primarily as a very thin zone of charcoal, possibly redeposited from elsewhere in site.
21	a thin (<1.0 ft) light reddish to yellowish brown sand that sloped sharply downward and thinned to west, was apparently highly disturbed and eroded, and contained limited amounts of cultural materials, probably redeposited.
22	a thin (<1.5 ft) reddish sand of restricted exposure, found within shelter. It contained limited cultural material in its upper portions, mainly ash, charcoal, and burned rock. The lower part of this stratum was a sterile sand with at least one very thin reddish silt layer between upper and lower sands.

Table 2.4: Description of Arenosa Shelter's Lower Strata (23 - 42).

Stratum	Location	Description
23	upper surface of roof spall to rear wall of shelter, gently arching shelterward from roof spall but dipping sharply and thickening to west	thick (>3 ft), generally soft and uncompacted medium brown sand that contains considerable amounts of charcoal, ash, burned rock, shell, and large variety of lithic material. Noted by field notes as flood disturbed and redeposited as gully fill with a major unconformity at its base.
23A	upper surface of roof spall towards rear wall of shelter, relatively horizontal near roof spall but dipping sharply and thickening to west	relatively thick (up to 1.5 ft) light reddish fine-grained alluvial sand with darker fine laminations, generally loose and soft in texture and culturally sterile except at contact with overlying stratum and in rodent burrow fill.
23B	upper surface of roof spall towards rear wall of shelter, horizontally bedded and apparently eroded away to west	thin (< 1.0 ft) light reddish fine-grained alluvial sand with darker fine laminations, generally loose and soft in texture that contains significant amounts of charcoal, ash, burned rock, shell, and large variety of chipped and ground stone material including mortars. Pockets of coarse yellowish sand occur in substratum.

Stratum	Location	Description
23C	upper surface of roof spall towards rear wall of shelter, relatively horizontally bedded, eroded away to west	thick (>1.5 ft) distinctly reddish fine-grained alluvial sand with few darker laminae, generally loosely compacted and apparently culturally sterile.
23D	upper surface of roof spall towards rear wall of shelter, horizontally bedded and apparently eroded away to west	thin (< 1.0 ft) light reddish fine-grained silty sand with darker fine laminations, generally loose and soft in texture that contains significant amounts of charcoal, ash, burned rock, shell, and large variety of chipped and ground stone material including mortars.
24	upper surface of roof spall towards rear wall of shelter, relatively horizontally bedded, eroded away to west	thick (>1.5 ft) distinctly reddish fine-grained alluvial sand with few darker laminae, generally loosely compacted and apparently culturally sterile.
25A	dipping sharply from upper surface of roof spall towards rear wall of shelter, relatively horizontally bedded north of spall eroded away to west	thin (0.2 ft) layer of reddish silt with associated cultural debris that includes charcoal and sparse burned rock.

Stratum	Location	Description
25B	relatively horizontally bedded zone north of spall towards rear wall of shelter, eroded away to west	thin (0.2 ft) layer of reddish sand with associated cultural debris that includes charcoal and sparse burned rock
26	upper rear face of roof spall to rear wall of shelter, gently dipping in rear half	relatively thick (1.5 ft) culturally sterile, pink fine to medium alluvial sand that contains alternating dark laminae and light graded beds.
27	trends gently downward from abutment with upper rear face of roof spall to rear wall of shelter	thin (0.1 ft) dense, homogenous reddish silt to clayey silt that is culturally sterile, except at its contact with the underlying stratum
28	trends gently downward from abutment with upper rear face of roof spall to rear wall of shelter	thin (up to 0.1 ft at rear of shelter) medium brown silt that contains snail and mussel shells, flint debitage and tools, scattered burned rock, and at least two thin hearths that were noted as undisturbed by subsequent deposition
29	trends gently downward from abutment with upper rear face of roof spall to rear wall of shelter	light reddish to reddish yellow fine grained sand, apparently structureless and culturally sterile

Stratum	Location	Description
30	trends gently downward from abutment with upper rear face of roof spall to rear wall of shelter	complex of occupational debris (including several intact hearths) contained within a thin (0.9 ft) layer of reddish to reddish brown silt. Between N200 and rear wall, may be separated into upper and lower components on basis of color. Upper component is red silt, lower component is reddish brown silt.
31 (undiff.)	between a transition with coarser substratum 31A and rear wall, thickens as a wedge and dips towards rear of shelter	tan, fine-grained structureless sand that is culturally sterile. It attains a maximum thickness of about 6 feet at N215.
31A	from upper rear surface of large roof spall, truncates underlying Substratum 31B and the Stratum 32 - 33 complex, grading into Stratum 31 (undiff.) at about N205	soft yellowish sand graded from coarse to medium in texture, containing low concentrations of very small natural limestone spalls and larger blocky burned rocks near its base. Poorly sorted beds also visible. Noted as high-energy flood deposit when defined.

Stratum	Location	Description
31B	extending short distance towards rear wall of the shelter from upper rear face of large roof spall, grading into Stratum 31 (undiff.) at N205, virtually truncating underlying strata 32, 33D, and 33 (undiff.)	relatively homogenous light reddish sand with no well developed graded beds visible
32	nearly horizontal orientation from spall contact out about 7 feet to where it is forced downward by Stratum 31B at N200. From N200 to rear wall, stratum dips sharply downwards towards the rear wall in a convex arc	two facies differentiated-- near horizontal and spally lag. Near horizontal facies lies between roof spall and N200, spally lag is between N200 and rear wall. Near horizontal facies composed of moderate concentrations of blocky burned limestone frags, tabular natural limestone spalls (<0.3 ft diameter), tiny limestone fragments, silt balls, flint debitage and artifacts, grinding slabs, snail and mussel shell, and charcoal lumps in a matrix of ungraded coarse yellowish sand. Spally lag facies consists of lag deposit of natural and burned limestone spalls in a yellowish ungraded coarse sand matrix. Little or no shell is found in this facies. Flat faces of the small spalls in spally lag facies oriented conforming to downwards steep slope towards the rear of the shelter. Redeposition of stratum noted by evidence of unsorted structureless “soft” sand matrix, variable slope, truncation of lower strata, and lack of cultural features, such as hearths found in strata 28 and 30
33	remnant substrata in stratum extend shelter-ward from middle and upper rear face of large roof spall	at least 5 separate substrata were defined during excavation--33A, 33B, 33C, 33D, and 33 (undiff.)

Stratum	Location	Description
33A	uppermost substratum, truncated by stratum 32, extends between N193 and N196 in W163 profile	very fine grained sand to silty sand, rusty red in color, apparently sterile, and was up to 0.45 ft thick
33B	extends upward and shelterward from contact with roof spall surface at N194, also truncated by Stratum 32 at about N197 in the W163 profile	relatively thin (0.15 ft) dark brown to gray sand, carbon stained due by cultural activity
33C	extends upward and shelterward from contact with roof spall surface at N195 to Stratum 32 truncation at N203 in W163 profile	relatively thick (max. 2.5 ft) “soft” unstructured light reddish sand
33D	extends upward and shelterward from contact roof spall at about N197 to point where it was truncated by Stratum 32 or Substratum 31B at N203	lowest designated substratum of Stratum 33, relatively thin (max. 0.5 ft) and unstructured, composed of a rusty red silty very fine-grained sand. A layer of 0.5 ft diameter burned blocky spalls at base of this substratum was considered to be in primary context when excavated

Stratum	Location	Description
33 (undiff.)	extends upward and shelterward from contact roof spall at about N197 to Stratum 32 (spally lag) truncation at about N207	basal unit in Stratum 33, it overlies Stratum 34 and was defined as a loose, unstructured reddish sand
34	extends shelterward in a slight upward arc from lower middle face of roof spall in vicinity of N199 to truncation by Stratum 33 (undiff.) at N204	similar to Stratum 32 (spally lag) facies, relatively thin (0.5 ft), consists of unstructured coarse yellowish sand that contains redeposited natural limestone spalls, blocky burned rocks, flint tools and projectile points, and other cultural debris
35	extends shelterward lower face of large spall between N200 and N201. Contact with Stratum 36 traces downward dipping arc towards the shelter's rear wall to limit of excavations. Upper extent truncated by the Stratum 32 (spally lag) facies shelterward of N207	relatively thick (4.5 feet thick) fine grained light reddish sand with no obvious structure

Stratum	Location	Description
36	originates from the lower roof spall between N201 and N205, sweeps shelterward and obliquely downward along lower face of the spall to its inner edge, then shelterward in an arc towards the rear margin of the excavation.	thin rocky stratum (up to 0.4 ft) along roof spall contact, characterized by a high concentration of natural and blocky burned rock, many <0.4 ft diameter, deposited as lag. Smaller spalls or pebbles are rounded. Surrounding matrix is medium coarse sand (color unspecified, possibly yellowish) and very small angular rock fragments. The spally lag is absent between N209 and the rear wall of the rear margin of the excavations.
37	extends from under the roof spall towards the shelter's rear wall, truncated by the convex lower surface of overlying Stratum 36	Stratum 37 thins in the direction of the shelter's inner margin and contains three defined subunits.
37 (undiff.)	upper part of Pit D under roof spall to the rear margin of excavation units at N215	upper margin bounded by lower face of the spall and convex lower margin of Stratum 36, consists of dense yellowish fine grained sand with weakly developed laminae of reddish brown silt

Stratum	Location	Description
37B	upper part of the N204 profile in Pit D under roof spall, occupies middle portion of depression or channel in that profile.	possibility gully or channel fill, overlies Substratum 37A in middle and western part of N204 profile and consists of fine reddish sand with thin laminae of buff silt which dip slightly from horizontal towards west
37A	lower part of N204 profile in Pit D under roof spall, base of depression or channel in that profile	basal deposit of Stratum 37, consists of unlaminated reddish silty fine sand with increasing silt basally, base marked by $^1/_8$-inch silt drape
38	small, wedge shaped zone in southeastern portion of Pit D, under the large roof spall, dipping moderately steeply towards river	six stratified, but undifferentiated, zones of silt or sandy silt. Two contained charcoal, flint debitage and unifacial tools, shell, and very small amounts of bone. Color undifferentiated.
39	extends from Pit D under roof spall to shelterward limit of excavation	Stratum 39 thins in the direction of the shelter's inner margin and contains four defined subunits.
39 (undiff.)	extends shelterward in W167 profile between N212 and the northern limit of excavation	wedge of yellowish sand, thins towards rear wall of shelter, not noted with structure

Stratum	Location	Description
39A	wedge shaped zone in middle portion of eastern Pit D profile under the large roof spall (W167), dipping moderately steeply towards river, extends shelterward from edge of roof spall to N212	moderately thick (>0.5 ft) wedge of medium fine reddish sand, bottom half has distinct laminated, graded beds
39B	wedge shaped zone in middle and lower of eastern Pit D profile under the large roof spall (W167), dipping moderately steeply towards river, extends shelterward from edge of roof spall to N212	complex zone, contained uneven layering of laminated, medium coarse yellowish sand at base, with laminations appearing uneven and slightly cross-bedded in places. Upper half of substratum was structureless and contained flecks of charcoal in its northern exposure.
39C	lower eastern Pit D profile under the large roof spall (W167), dipping moderately steeply towards river, extends shelterward from edge of roof spall to N212	thin (<0.1 ft) unit of mixed reddish silt, coarse yellowish weathered limestone dust, and very small natural limestone spalls. Limestone dust matrix is weathered and has the appearance of medium coarse sand.

Stratum	Location	Description
40	lower sections of the deepest units excavated and slopes gently towards the river	Stratum 40 contains two defined subunits.
40A	extends in a discontinuous layer across Pits D, E, and F between N204 and N214, being continuous in the southern half of Pit D as discontinuous pockets elsewhere	thin (<0.5 ft) layer of dark red silt which drapes over most of Feature 18, although some of the bones in this feature are contained entirely within Substratum 40A
40B	extends in a continuous layer across the lower excavation units and forms the base of Pit D as excavated.	thin (0.5 ft) yellowish red fine-grained sand with sparse small (<0.25 ft) angular limestone spalls at its base. No apparent laminations or other structure recorded. Two large (0.5 ft) limestone spalls associated with Feature 18.
41	extends in a continuous layer across lower excavation units except Pit D.	Stratum 41 contains five defined subunits that dip gently towards the river.
41A	substratum at top of Stratum 41 does not extend to the north wall of lower excavation units.	wedge-shaped layer of fine-grained reddish sand, thickens to about 0.2 ft towards the river. Substratum homogenous, with no laminations or other reported structure. Contact with the underlying substratum is abrupt and irregular.

Stratum	Location	Description
41B	extends in a continuous layer across lower excavation units except Pit D	thin (0.2 ft) silt with abrupt and distinct irregular contacts with the sands that underlie and overlie it. No color was recorded for it.
41C	extends in a continuous layer across lower excavation units except Pit D	yellowish medium to coarse-grained sand, distinctly laminated, with laminae following general incline towards river.
41D	extends in a continuous layer across lower excavation units except Pit D	light reddish brown sand that has a relatively even contact with the overlying Substratum 41C sand. It is fine grained and exhibits graded laminations.
41E	extends in a continuous layer across lower excavation units except Pit D	medium reddish brown fine silty sand or silt with somewhat darker laminations dense, resting above the abrupt and even contact with underlying Stratum 42. It follows the same riverward-downward trend as the remainder of Stratum 41.
42	extends in a continuous layer across lower excavation units except Pit D	lowest stratum defined in the deep excavation units at Arenosa Shelter and defined to include five separate zones, although they were not labeled as separate substrata by Dibble.
42 (spall zone 1)	extends in a continuous layer across lower excavation units except Pit D	thin (0.7 ft avg.) zone of angular to sub angular limestone spalls in a matrix of buff colored coarse ungraded sand. The spalls are jumbled and rest at various angles to their long axes.

Stratum	Location	Description
42 (silt zone 2)	extends in a discontinuous layer across lower excavation units except Pit D, incompletely separating spall zones above and below it	thin pockets or discontinuous lenses of reddish fine sand or silty sand
42 (spall zone 3)	extends in continuous layer across lower excavation units except Pit D	thin (0.5 ft) layer of small to medium sized angular limestone spalls that are bedded in a matrix of light brown fine sand. The long axes of the larger spalls generally conform to the riverward-dipping trend of the stratum.
42 (silt zone 4)	extends in a thin lens across Pit E and eastern Pit F and a discontinuous layer across lower excavation units, except Pit D, incompletely separating spall zones above and below it	thin zone of medium reddish brown very fine sand or silty sand
42 (spall zone 5)	extends in a continuous layer across lower excavation units except Pit D	thin (0.4 ft) zone composed of lightly weathered, large spalls (≤1.5 ft diameter) in a matrix of whitish weathered limestone dust. The orientation of the long axes of spalls in this zone conforms to the riverward-dipping trend of the stratum.

Stratum	Location	Description
43?	deepest test in Pit F	basal stratum recorded in field notes, but undefined by Dibble, consists of at least 3.0 ft. of only slightly weathered small to medium-sized tabular spalls in a matrix of coarse ungraded buff colored sand.

Table 2.5: Summary of Projectile Point Forms From Arenosa Shelter Aggregated by Cultural Stage.

Cultural Stage	Projectile Point Forms
Late Prehistoric	*Perdiz, Perdiz*-like, *Clifton* (preform), *Clifton*-like (preform), *Harrell, Toyah, Catan, Abasolo*-like
Archaic	Early-Barbed, *Martindale/Bandy, Uvalde/Baker, Pandale, Langtry, Langtry-like, Val Verde, Val Verde*-like, *Montell, Marcos, Marcos*-like, *Pedernales, Shumla, Shumla*-like, *Palmillas, Ensor, Ensor*-like, *Frio, Frio*-like, and *Darl*-like

Appendix 2

Table 5.1: Taxa Identified from Composite Arenosa Shelter Faunal Sample.

Class	Order	Family	Genus	Species	Common Name
Osteichthyes					bony fish (undetermined species)
	Acipenseriformes	Acipenseridae	*Scaphirhynchus*	*platorhynchus*	shovelnose sturgeon
	Lepisosteiformes	Lepisosteidae	*Lepisosteus*	cf. *spatula*	alligator gar
			Lepisosteus	*osseus*	longnose gar
			Lepisosteus	sp.	gar (undetermined species)
	Siluriformes	Ictaluridae			catfish (undetermined species)
			Ictalurus	*furcatus*	blue catfish
			Ictalurus	*punctatus*	channel catfish
			Ictalurus	*melas*	black bullhead
			Ictalurus	*natalis*	bullhead
			Ictalurus	sp.	catfish (undetermined species, *subgenus Ictulurus*)
			Ictalurus	sp.	catfish (undetermined species)
			Pylodictis	*olivaris*	flathead catfish
	Cypriniformes				sucker or minnow (undetermined species)
		Catostomidae			sucker (undetermined species)
			Carpiodes	*carpio*	river carpsucker
			Catostomus	sp.	sucker fish

Class	Order	Family	Genus	Species	Common Name
			Cycleptus	*elongatus*	blue sucker
			Ictiobus	*niger*	black buffalo
			Ictiobus	*bubalus*	smallmouth buffalo
			Ictiobus	sp.	buffalo (undetermined species)
	Perciformes				perciform fish (undetermined species)
		Centrarchidae			temperate bass (undetermined species)
			Micropterus	*salmoides*	largemouth bass
			Micropterus	sp.	temperate bass (undetermined species)
		Scianidae	*Aplodinotus*	*grunniens*	freshwater drum
		Serranidae	*Morone*	*chrysops*	white bass
			Morone	sp.	serranid bass (undetermined species)
Amphibia	Anura	Ranidae	*Rana*	*catesbiana*	bullfrog
			Rana	*pipiens*	leopard frog
Reptilia	Chelonia				turtle (undetermined species)
		Chelydridae	*Chelydra*	*serpentina*	snapping turtle
		Emydidae	*Pseudemys*	sp.	slider turtle (undetermined species)
		Testudinidae			terrapin (undetermined species)
		Trinychidae	*Trionyx*	*spiniferus*	spiny softshell turtle
	Squamata	Colubriadae	*Coluber* or *Masticophis*	*constrictor* or *flagellum*	racer or coachwhip snake
			Pituophis	sp.	bullsnake
		Crotalidae			pit viper (undetermined species)

Class	Order	Family	Genus	Species	Common Name
			Crotalus	*atrox*	Western diamondback rattlesnake
			Agkistrodon	*contortrix*	copperhead
			Crotalus or Agkistrodon	sp.	rattlesnake or copperhead
Aves					bird (undetermined species)
	Anseriformes	Anatidae			duck (undetermined species)
			Aythya	*americana*	canvasback duck
			Aythya	sp.	canvasback, scaup, or redhead duck (undetermined species)
			cf. *Aythya* or *Melanitta*	sp.	diving duck (undetermined species)
			Anas	*platyrhynchus*	mallard
				cf. *strepera*	gadwall
				cf. *discors* or *carolinensis*	blue-winged or green-winged teal
			Anas or Branta	sp.	duck or goose (undetermined species)
			Branta	*canadensis*	Canada goose
			Chen	sp.	goose (undetermined species)
	Charadriiformes	Laridae			gull (undetermined species)
	Cuculiformes	Cuculidae	*Geococcyx*	*californicus*	roadrunner
	Falconiformes				falcon or hawk (undetermined species)
		Accipitridae			hawk (undetermined species)
			Buteo	cf. *lineatus*	red-tailed hawk

Class	Order	Family	Genus	Species	Common Name
			Buteo	cf. *jamaicensis*	red-shouldered hawk
			Buteo	cf. *lineatus* or *jamaicensis*	red-tailed or red-shouldered hawk
			Buteo	sp.	broad-winged hawk (undetermined species)
			Falco	cf. *sparverius*	sparrow hawk
			cf. *Falco*	sp.	small hawk (undetermined species)
			cf. *Ictinia*	*mississippiensis*	Mississippi kite
			Ictinia or *Falco*	sp.	small hawk or kite (undetermined species)
	Galliformes	Phasianidae	*Colinus*	*virginianus*	bobwhite quail
			cf. *Colinus* or *Callipepla*	*virginianus* or *squamata*	bobwhite or scaled quail
			Meleagris	*gallapavo*	turkey
	Columbiformes	Columbidae	*Zenaida*	*asiatica*	white-winged dove
Mammalia	Ariodactyla				artidactyl (undetermined species)
					large deer (undetermined species)
			Odocoileus	cf. *hemionus*	mule deer
			Odocoileus	*virginianus*	white-tail deer
			Odocoileus	*sp.*	deer (undetermined species)
		Antilocapridae	*Antilocapra*	*americana*	pronghorn antelope
		Bovidae	*Ovis*	*sp.*	sheep
			Ovis or *Capra*	*sp.*	sheep or goat
			Bison	*antiquus*	extinct Pleistocene bison

Class	Order	Family	Genus	Species	Common Name
			Bison	*bison*	modern bison
			cf. *Bison* or *Bos*	sp.	bison or cow
	Perrisodactyla	Equidae	*Equus*	sp.	extinct Pleistocene horse (undetermined large species)
			Equus	sp.	extinct Pleistocene horse (undetermined species)
	Lagomorpha	Leporidae			rabbit (undetermined species)
			Lepus	*californicus*	blacktail jackrabbit
			Sylvilagus	*audobonii*	desert cottontail
			Sylvilagus	*floridanus*	Eastern cottontail
			Sylvilagus	cf. *audobonii* or *floridanus*	Desert or Eastern cottontail
			Sylvilagus	sp.	cottontail (undetermined species)
	Rodentia				rodent (undetermined species)
		Castoridae	*Castor*	*canadensis*	beaver
		Cricetidae	*Neotoma*	*albigula*	white-throated woodrat
			Neotoma	cf. *albigula*	white-throated woodrat
			Neotoma	*floridana*	Florida woodrat
			Neotoma	*micropus*	Plains woodrat
			Neotoma	sp.	woodrat (undetermined species)
			Ondatra	*zibethicus*	muskrat
			Sigmodon	*hispidus*	hispid cottonrat

Class	Order	Family	Genus	Species	Common Name
			Sigmodon	sp.	cottonrat (undetermined species)
		Geomyidae	*Geomys*	*personatus*	Tamaulipan pocket gopher
			Pappogeomys	*castanops*	Plains pocket gopher
		Sciuridae	*Sciurus*	cf. *niger*	gray squirrel
			Spermophilus	*mexicanus*	Mexican ground squirrel
			Spermophilus	*variegatus*	rock squirrel
	Carnivora				carnivore (undetermined species)
	Carnivora				small carnivore (undetermined species)
	Carnivora				large carnivore (undetermined species)
		Canidae			small canid (undetermined species)
		Canidae			large fox (undetermined species)
			Vulpes	*vulpes*	red fox
			Vulpes	cf. *vulpes* or *velox*	red or kit fox
			Vulpes	*velox*	kit fox
			cf. Vulpes	*velox*	kit fox
			Urocyon	*cinereoargenteus*	gray fox
			Canis	*familiaris*	domestic dog
			Canis	*latrans*	coyote
			Canis	cf. *familiaris* or *latrans*	domestic dog or coyote
		Felidae	*Lynx*	*rufus*	bobcat

Class	Order	Family	Genus	Species	Common Name
		Mephitidae	cf. *Mephitis or Conepatus*	sp.	large skunk (undetermined species)
			Spilogale	sp.	spotted skunk
		Mustelidae	*Taxidea*	*taxus*	badger
		Procyonidae	*Bassariscus*	*astutus*	ring-tail
			Procyon	*lotor*	raccoon
			Procyon	cf. *lotor simus*	raccoon (extirpated large subspecies)
Mammalia					small mammal (undetermined species)
Mammalia					small – medium mammal (undetermined species)
Mammalia					medium mammal (undetermined species)
Mammalia					medium - large mammal (undetermined species)
Mammalia					large mammal (undetermined species)
Mammalia					large mammal (large deer-sized, undetermined species)
Mammalia					large mammal (small horse size, undetermined species)
Mammalia					large mammal (Bison-sized, undetermined species)
Mammalia					large mammal (large horse-bison size, undetermined species)

Table 5.2: Quantification of Taxa by Provenience Unit.

Horizontal Provenience	**Stratum**	**Substratum**	**Taxon**	**NISP**	**MNI**	**MNE**
N180-191/W160	7	full cut	Osteichthyes	120	5	5
			Lepisosteus sp.	22	3	3
			Ictaluridae	91	3	3
			Ictalurus furcatus	2	1	1
			Ictalurus punctatus	7	4	4
			Ictalurus sp., subgenus *Ictulurus*	3	3	3
			Ictalurus melas	1	1	1
			Ictalurus sp.	11	1	1
			Pylodictis olivaris	4	2	2
			Cypriformes	22	6	6
			Carpiodes carpio	6	4	4
			Catostomidae	26	4	4
			Centrarchidae	1	1	1
			Aplodinotus grunniens	19	1	1
			Rana pipiens	2	1	1
			Pituophis sp.	1	1	1
			Crotalus sp.	1	1	1
			Coluber constrictor or *Masticophis flagellum*	2	1	1
			Trionyx spiniferus	10	1	1

Horizontal Provenience	Stratum	Substratum	Taxon	NISP	MNI	MNE
			Pseudemys sp.	1	1	1
			Chelonia	2	1	1
			Aves	5	2	2
			Buteo sp.	1	1	1
			Falco sp.	5	1	1
			cf. *Colinus virginianus* or *Callipepla squamata*	9	3	3
			Zenaida asiatica	2	1	1
			Anatidae	1	1	1
			Anatidae (size of *Aix sponsa)*	1	1	1
			Anatidae (size of *Anas platyrhynchus*)	1	1	1
			Artiodactyla	23	2	2
			Bison bison	1	1	1
			Odocoileus sp.	9	1	1
			Antilocapra americana	3	1	1
			Leporidae	7	7	7
			Lepus californicus	117	13	13
			Sylvilagus audobonii or *floridanus*	276	22	22
			Rodentia	8	2	2
			Castor canadensis	1	1	1
			Neotoma micropus	7	1	1

Horizontal Provenience	Stratum	Substratum	Taxon	NISP	MNI	MNE
			Neotoma sp.	3	3	3
			Sigmodon hispidus	12	6	6
			Spermophilus mexicanus	1	1	1
			Spermophilus variegatus	2	1	1
			Canis cf. *familiaris* or *latrans*	11	2	2
			Canis sp.	9	1	1
			Urocyon cinereoargenteus	1	1	1
			Vulpes velox	2	1	1
			Spilogale sp.	2	2	2
			Bassariscus astutus	2	1	1
			Procyon lotor	1	1	1
			small carnivore (undetermined species)	1	1	1
			large carnivore (undetermined species)	1	1	1
			Mammalia	539	2	2
N200/W160	2 & 3	mixed, full cut	Osteichthyes	2	1	1
			Lepisosteus sp.	7	2	2
			Ictalurus punctatus	1	1	1
			Ictalurus sp.	5	2	2
			Trionyx spiniferus	1	1	1
			Artiodactyla	2	1	1

Horizontal Provenience	Stratum	Substratum	Taxon	NISP	MNI	MNE
			Odocoileus sp.	11	2	2
			Bison or *Bos* sp.	1	1	1
			Lepus californicus	5	2	2
			Sylvilagus audobonii or *floridanus*	5	2	2
			Castor canadensis	1	1	1
			Bassariscus astutus	1	1	1
			Procyon lotor	1	1	1
			large mammal	3	2	2
			indeterminate mammal	1	1	1
	4	full cut	Osteichthyes	2	1	1
			Lepisosteus sp.	6	2	2
			Ictaluridae	4	1	1
			Crotalus or *Agkistrodon* sp.	1	1	1
			Odocoileus sp.	1	1	1
			Lepus californicus	1	1	1
			Sylvilagus audobonii or *floridanus*	3	2	2
			Ondatra zibethicus	1	1	1
			Urocyon cinereoargenteus	1	1	1
	5	full cut	Osteichthyes	43	3	3
			Lepisosteus sp.	14	2	2

Horizontal Provenience	**Stratum**	**Substratum**	**Taxon**	**NISP**	**MNI**	**MNE**
			Ictaluridae	1	1	1
			Ictalurus furcatus	9	6	6
			Ictalurus punctatus	3	2	2
			Ictalurus sp.	15	3	3
			Pylodictis olivaris	2	2	2
			Carpiodes carpio	1	1	1
			Rana pipiens	1	1	1
			cf *Colinus virginianus* or *Callipepla squamata*	2	1	1
			Odocoileus sp.	6	1	1
			Lepus californicus	21	4	4
			Sylvilagus audobonii	1	1	1
			Sylvilagus audobonii or *floridanus*	38	7	7
			Castor canadensis	1	1	1
			Ondatra zibethicus	2	2	2
			Sigmodon hispidus	3	2	2
			Spermophilus variegatus	1	1	1
			Canis cf. *familiaris* or *latrans*	1	1	1
			Vulpes vulpes	1	1	1
			Procyon cf. *lotor simus*	1	1	1
			medium - large mammal (undetermined species)	1	1	1

Horizontal Provenience	Stratum	Substratum	Taxon	NISP	MNI	MNE
			large mammal (undetermined species)	7	1	1
			Mammalia (undetermined species)	2	1	1
	7	full cut	*Lepisosteus* sp.	5	1	1
			Ictalurus sp.	12	2	2
			Pylodictis olivaris	1	1	1
			Odocoileus sp.	1	1	1
			Lepus californicus	6	1	1
			Sylvilagus audobonii or *floridanus*	8	2	2
	9 - 19	mixed, full cut	Osteichthyes	16	2	2
			Lepisosteus sp.	4	2	2
			Ictalurus furcatus	1	1	1
			Ictalurus sp., subgenus *Ictulurus*	5	1	1
			Ictalurus sp.	17	3	3
			Pylodictis olivaris	14	2	2
			cypriniform sucker or minnow (undetermined species)	2	2	2
			Carpiodes carpio	4	1	1
			Cycleptus elongatus	3	1	1
			Aplodinotus grunniens	31	5	5
			Rana catesbiana	2	1	1
			Trionyx spiniferus	3	2	2

Horizontal Provenience	Stratum	Substratum	Taxon	NISP	MNI	MNE
			Aves (undetermined large bird species)	3	2	2
			Anas cf. *discors* or *carolinensis*	1	1	1
			cf. *Aythya* or *Melanitta* sp.	1	1	1
			Anas or *Branta* sp.	1	1	1
			Accipitridae (size similar to *Accipiter cooperi*)	1	1	1
			Buteo cf. *jamaicensis*	1	1	1
			Ictinia or *Falco* sp.	1	1	1
			cf *Colinus virginianus* or *Callipepla squamata*	4	1	1
			Ariodactyla	1	1	1
			Odocoileus sp.	6	1	1
			Lepus californicus	39	7	7
			Sylvilagus audobonii or *floridanus*	76	6	6
			Castor canadensis	1	1	1
			Pappogeomys castanops	1	1	1
			Sciurus cf. *niger*	1	1	1
			Spermophilus variegatus	5	2	2
			cf. *Canis latrans*	4	2	2
			cf. *Urocyon cinereoargenteus*	2	2	2
			cf. *Vulpes velox*	1	1	1
			large fox (undetermined species)	1	1	1

Horizontal Provenience	Stratum	Substratum	Taxon	NISP	MNI	MNE
			Lynx rufus	1	1	1
			small mammal (undetermined species)	33	4	4
			small – medium mammal (undetermined species)	1	1	1
			medium mammal (undetermined species)	12	2	2
			medium - large mammal (undetermined species)	2	1	1
			large mammal (deer-sized, undetermined species)	1	1	1
N200/W163	19-23A	mixed, full cut	*Trionyx spiniferus*	1	1	1
			Ariodactyla	2	1	1
			Odocoileus cf. *hemionus*	4	2	2
			Antilocapra americana	3	2	2
			Lepus californicus	1	1	1
			medium - large mammal (undetermined species)	2	1	1
	23	23B, full cut	*Lepus californicus*	1	1	1
	23	23D, full cut	*Canis* cf. *familiaris* or *latrans*	1	1	1
	25	full cut	Ariodactyla	2	1	1
			large mammal (undetermined species)	1	1	1
N200/W167	30	lower cut	Perciformes	1	1	1
			Odocoileus sp.	4	3	3
N200/W170	2	cut 1	Lepisosteus sp.	2	2	1
			Ictalurus furcatus	2	1	1

Horizontal Provenience	Stratum	Substratum	Taxon	NISP	MNI	MNE
			Ictalurus sp.	1	1	1
			Pylodictis olivaris	3	2	2
			Catostomidae	1	1	1
			Ictiobus niger	4	2	2
			Micropterus salmoides	1	1	1
			Agkistrodon contortrix	1	1	1
			Trionyx spiniferus	1	1	1
			Testudinidae	1	1	1
			Ovis sp.	1	1	1
			Ovis or *Capra* sp.	15	2	2
			Lepus californicus	3	2	2
			Sylvilagus audobonii or *floridanus*	6	2	2
			Neotoma albigula	1	1	1
			Neotoma cf. *albigula*	1	1	1
			Sigmodon hispidus	1	1	1
			Urocyon cinereoargenteus	1	1	1
			small – medium mammal (undetermined species)	1	1	1
			medium mammal (undetermined species)	1	1	1
			large mammal (undetermined species)	1	1	1
	2	cut 2	*Ictalurus* sp.	9	1	1

Horizontal Provenience	Stratum	Substratum	Taxon	NISP	MNI	MNE
			Catostomidae	10	2	2
			Trionyx spiniferus	2	1	1
			Artiodactyla	1	1	1
			Odocoileus virginianus	6	1	1
			cf. *Antilocapra americana*	2	1	1
			Lepus californicus	2	1	1
			Sylvilagus audobonii or *floridanus*	19	4	4
			Castor canadensis	1	1	1
			Urocyon cinereoargenteus	1	1	1
			Procyon lotor	1	1	1
			large mammal (undetermined species)	8	1	1
	3	full cut	*Lepisosteus* sp.	5	1	1
			Ictaluridae	2	2	2
			Ictalurus furcatus	5	5	5
			Pylodictis olivaris	55	5	5
			Cycleptus elongatus	2	1	1
			Ictiobus bubalus	6	3	3
			Catostomidae	19	2	2
			Micropterus salmoides	2	1	1
			Centrarchidae	7	1	1

Horizontal Provenience	Stratum	Substratum	Taxon	NISP	MNI	MNE
			Trionyx spiniferus	2	1	1
			Odocoileus virginianus	2	1	1
			Odocoileus sp.	33	1	1
			Lepus californicus	9	4	4
			Sylvilagus audobonii or *floridanus*	32	4	4
			Neotoma sp.	1	1	1
			Sigmodon hispidus	8	6	6
			Spermophilus variegatus	1	1	1
			Canis familiaris	3	1	1
			Urocyon cinereoargenteus	3	2	2
			Bassariscus astutus	1	1	1
			Procyon lotor	2	2	2
	4	full cut	*Lepisosteus* sp.	12	1	1
			Ictalurus furcatus	3	3	3
			Ictalurus sp.	13	3	3
			Pylodictis olivaris	6	3	3
			Cycleptus elongatus	3	1	1
			Trionyx spiniferus	2	1	1
			Anas platyrhynchus	1	1	1
			Buteo cf. *lineatus* or *jamaicensis*	1	1	1

Horizontal Provenience	Stratum	Substratum	Taxon	NISP	MNI	MNE
			Colinus virginianus	2	1	1
			Artiodactyla	1	1	1
			Odocoileus cf. *hemionus*	3	2	2
			Odocoileus sp.	14	1	1
			Lepus californicus	10	2	2
			Sylvilagus audobonii or *floridanus*	40	5	5
			Neotoma albigula	3	1	1
			Neotoma sp.	1	1	1
			Sigmodon hispidus	2	2	2
			Spermophilus variegatus	1	1	1
			Canis latrans	1	1	1
			Canis cf. *familiaris* or *latrans*	1	1	1
			Vulpes cf. *vulpes*	1	1	1
			Urocyon cinereoargenteus	1	1	1
			Bassariscus astutus	2	1	1
			Procyon lotor	2	1	1
	5	cut 1	*Lepisosteus* cf. *spatula*	29	1	1
			Ictalurus furcatus	6	5	5
			Ictalurus sp.	10	2	2
			Pylodictis olivaris	27	4	4

Horizontal Provenience	Stratum	Substratum	Taxon	NISP	MNI	MNE
			Catostomidae	5	1	1
			Carpiodes carpio	1	1	1
			Cycleptus elongatus	10	2	2
			Ictiobus sp.	6	2	2
			Odocoileus sp.	7	1	1
			Antilocapra americana	1	1	1
			Lepus californicus	12	2	2
			Sylvilagus audobonii or *floridanus*	36	12	12
			Neotoma sp.	3	1	1
			Ondatra zibethicus	6	4	4
			Sigmodon hispidus	3	2	2
			Geomys personatus	1	1	1
			Spermophilus cf. *mexicanus*	1	1	1
			Spermophilus variegatus	3	2	2
			Canis latrans	1	1	1
			Urocyon cinereoargenteus	1	1	1
			Bassariscus astutus	2	1	1
	5	cut 2	Osteichthyes	1	1	1
			Lepisosteus sp.	44	2	2
			Ictalurus furcatus	1	1	1

Horizontal Provenience	Stratum	Substratum	Taxon	NISP	MNI	MNE
			Ictalurus sp.	15	7	7
			Pylodictis olivaris	57	5	5
			Carpiodes carpio	21	3	3
			Cycleptus elongatus	9	4	4
			Catostomus sp.	2	1	1
			Ictiobus sp.	147	10	10
			Micropterus salmoides	2	1	1
			Micropterus sp.	5	1	1
			Morone chrysops	4	2	2
			Aplodinotus grunniens	1	1	1
			Trionyx spiniferus	4	1	1
			Agkistrodon contortrix	1	1	1
			Colinus virginianus	5	5	5
			Meleagris gallapavo	1	1	1
			Bison bison	3	1	1
			Odocoileus sp.	21	1	1
			Lepus californicus	20	6	6
			Sylvilagus audubonii or *floridanus*	39	6	6
			Castor canadensis	1	1	1
			Urocyon cinereoargenteus	2	1	1

Horizontal Provenience	Stratum	Substratum	Taxon	NISP	MNI	MNE
			Taxidea taxus	1	1	1
			Procyon lotor cf. *simus*	1	1	1
	7	full cut	Osteichthyes	1	1	1
			Lepisosteus osseus	1	1	1
			Ictalurus furcatus	1	1	1
			Ictalurus sp.	1	1	1
			Pylodictis olivaris	4	1	1
			Ictiobus sp.	7	2	2
			Trionyx spiniferus	2	1	1
			Odocoileus sp.	4	1	1
			Lepus californicus	46	8	8
			Sylvilagus audubonii or *floridanus*	234	10	10
			Neotoma sp.	1	1	1
			Sigmodon sp.	1	1	1
	9	cut 1	Osteichthyes	1	1	1
			Scaphirhynchus platyrhynchus	1	1	1
			Lepisosteus sp.	3	2	2
			Ictalurus furcatus	5	4	4
			Ictalurus punctatus	2	2	2
			Ictalurus sp.	7	2	2

Horizontal Provenience	Stratum	Substratum	Taxon	NISP	MNI	MNE
			Pylodictis olivaris	3	2	2
			Carpiodes carpio	1	1	1
			Cycleptus elongatus	2	1	1
			Ictiobus niger	1	1	1
			Ictiobus sp.	2	1	1
			Aplodinotus grunniens	3	1	1
			Trionyx spiniferus	1	1	1
			Buteo sp.	1	1	1
			Colinus virginianus	4	4	4
			Ariodactyla	1	1	1
			Odocoileus sp.	10	1	1
			Lepus californicus	45	8	8
			Sylvilagus audubonii or *floridanus*	100	10	10
			Neotoma albigula	1	1	1
			Sigmodon hispidus	1	1	1
			Spermophilus mexicanus	1	1	1
			Spermophilus variegatus	3	2	2
			Urocyon cinereoargenteus	1	1	1
			Vulpes cf. *vulpes* or *velox*	1	1	1
			small canid (undetermined species)	1	1	1

Horizontal Provenience	Stratum	Substratum	Taxon	NISP	MNI	MNE
			Spilogale sp.	2	2	2
			Bassariscus astutus	1	1	1
			Procyon lotor	1	1	1
			large mammal (undetermined species)	1	1	1
	9	cut 2	*Ictalurus furcatus*	4	4	4
			Ictalurus sp.	3	3	3
			Pylodictis olivaris	8	3	3
			Ictiobus sp.	1	1	1
			Aplodinotus grunniens	6	1	1
			Branta canadensis	1	1	1
			Colinus virginianus	5	2	2
			Trionyx spiniferus	4	2	2
			Odocoileus sp.	15	3	3
			Lepus californicus	23	5	5
			Sylvilagus audubonii or *floridanus*	79	12	12
			Neotoma albigula	3	2	2
			Spermophilus variegatus	5	2	2
			small canid (undetermined species)	1	1	1
			large fox (undetermined species)	2	2	2
			Bassariscus astutus	2	1	1

Horizontal Provenience	**Stratum**	**Substratum**	**Taxon**	**NISP**	**MNI**	**MNE**
			large mammal (undetermined species)	1	1	1
	9	cut 3	*Lepisosteus* sp.	3	1	1
			cf. *Ictalurus punctatus* or *mexicanus*	5	3	3
			Ictalurus sp.	5	2	2
			Pylodictis olivaris	4	3	3
			Morone chrysops	1	1	1
			Aplodinotus grunniens	4	1	1
			Trionyx spiniferus	6	1	1
			Chen sp.	1	1	1
			Colinus virginianus	1	1	1
			cf. *Colinus virginianus* or *Callipepla squamata*	1	1	1
			Ariodactyla	10	1	1
			Odocoileus cf. *hemionus*	3	1	1
			Odocoileus virginianus	2	1	1
			Odocoileus sp.	17	3	3
			Antilocapra americana	3	1	1
			Leporidae	1	1	1
			Lepus californicus	26	5	5
			Sylvilagus cf. *audubonii*	4	2	2
			Sylvilagus cf. *floridanus*	2	2	2

Horizontal Provenience	Stratum	Substratum	Taxon	NISP	MNI	MNE
			cf. *Sylvilagus audubonii* or *floridanus*	124	21	21
			Castor canadensis	1	1	1
			Neotoma sp.	1	1	1
			Sigmodon hispidus	3	2	2
			Pappogeomys castanops	1	1	1
			Spermophilus cf. *variegatus*	1	1	1
			Urocyon cinereoargenteus	1	1	1
			Bassariscus astutus	1	1	1
			Procyon lotor	1	1	1
	10	full cut	Osteichthyes	1	1	1
			Lepisosteus sp.	3	1	1
			Ictalurus furcatus	2	1	1
			Pylodictis olivaris	5	3	3
			Carpiodes carpio	1	1	1
			Ictiobus niger	5	3	3
			Aplodinotus grunniens	1	1	1
			Chelydra serpentina	1	1	1
			Trionyx spiniferus	3	1	1
			Crotalus atrox	1	1	1
			Aythya sp.	1	1	1

Horizontal Provenience	Stratum	Substratum	Taxon	NISP	MNI	MNE
			Falco cf. *sparverius*	1	1	1
			Ictinia cf. *mississippiensis*	1	1	1
			Odocoileus hemionus	1	1	1
			Odocoileus virginianus	1	1	1
			Odocoileus sp.	12	3	3
			Lepus californicus	9	6	6
			cf. *Sylvilagus audubonii* or *floridanus*	60	10	10
			Castor canadensis	1	1	1
			Neotoma cf. *albigula*	2	2	2
			Neotoma cf. *floridana*	1	1	1
			Neotoma sp.	3	1	1
			Sigmodon hispidus	2	2	2
			Spermophilus variegatus	4	2	2
			Vulpes velox	1	1	1
			large fox (undetermined species)	1	1	1
			Spilogale sp.	1	1	1
			large skunk (undetermined species)	1	1	1
	11	full cut	*Lepisosteus* sp.	2	2	2
			Ictalurus furcatus	2	1	1
			Ictalurus punctatus	6	4	4

Horizontal Provenience	Stratum	Substratum	Taxon	NISP	MNI	MNE
			Pylodictis olivaris	3	1	1
			Ictiobus niger	3	1	1
			Testudinidae	1	1	1
			Crotalidae	1	1	1
			Aythya americana	2	1	1
			Laridae	1	1	1
			Geococcyx californicus	1	1	1
			Accipitridae	1	1	1
			Odocoileus sp.	15	2	2
			Lepus californicus	3	2	2
			Sylvilagus cf. *audubonii*	4	2	2
			Sylvilagus cf. *floridanus*	1	1	1
			cf. *Sylvilagus audubonii* or *floridanus*	19	5	5
			Neotoma cf. *albigula*	1	1	1
			Neotoma cf. *floridana*	3	2	2
	12-18	mixed, full cut	*Lepisosteus* sp.	2	1	1
			Ictalurus furcatus	3	2	2
			Anas strepera	1	1	1
			Odocoileus cf. *hemionus*	1	1	1
			Odocoileus sp.	18	3	3

Horizontal Provenience	Stratum	Substratum	Taxon	NISP	MNI	MNE
			Lepus californicus	4	1	1
			Sylvilagus cf. *audubonii*	1	1	1
			cf. *Sylvilagus audubonii* or *floridanus*	14	5	5
			Castor canadensis	1	1	1
			Neotoma sp.	1	1	1
			cf. *Urocyon cinereoargenteus*	1	1	1
			Procyon lotor	1	1	1
	below stratum 20	mixed, full cut	*Ictalurus furcatus*	1	1	1
			Ictalurus sp.	1	1	1
			Ariodactyla (large deer size)	1	1	1
			Odocoileus cf. *hemionus*	4	2	2
			Odocoileus sp.	4	1	1
			Sylvilagus audubonii or *floridanus*	3	1	1
			Canidae	1	1	1
			small – medium mammal (undetermined species)	2	1	1
	21	full cut	*Pylodictis olivaris*	2	1	1
			Odocoileus sp.	3	1	1
			Sylvilagus audubonii or *floridanus*	1	1	1
	23	full cut	*Lepisosteus* sp.	1	1	1
			Ictalurus furcatus	1	1	1

Horizontal Provenience	Stratum	Substratum	Taxon	NISP	MNI	MNE
			Ictalurus punctatus	3	2	2
			Ictalurus sp.	2	2	2
			Pylodictis olivaris	3	1	1
			Trionyx spiniferus	3	2	2
			Ariodactyla	14	1	1
			Odocoileus cf. *hemionus*	1	1	1
			Odocoileus sp.	14	3	3
			Sylvilagus audubonii or *floridanus*	4	3	3
			Castor canadensis	2	1	1
			Neotoma albigula	1	1	1
			Procyon lotor	6	1	1
			large mammal (undetermined species)	1	1	1
	23	23D, Full cut	*Sylvilagus audubonii* or *floridanus*	4	1	1
			large mammal (undetermined species)	1	1	1
	25	full cut	Ariodactyla	2	1	1
			Canis cf. *familiaris* or *latrans*	6	1	1
			medium - large mammal (undetermined species)	1	1	1
N199/W174, Extension	28	full cut	Ariodactyla	1	1	1
			Rodentia	1	1	1
			small mammal (undetermined species)	1	1	1

Horizontal Provenience	Stratum	Substratum	Taxon	NISP	MNI	MNE
			Mammalia	3	1	1
	30 to trench bottom	mixed, full cut	Osteichthyes	2	1	1
			medium - large mammal (undetermined species)	3	1	1
	32	full cut	cf. *Vulpes velox*	1	1	1
	33	full cut	Osteichthyes	3	1	1
N205/W167	30	full cut	*Odocoileus* sp.	5	1	1
	32	full cut	*Odocoileus* sp.	3	1	1
N207/W170	30	full cut	*Odocoileus* sp.	14	2	2
Feature 17	30	full cut	Perciformes	1	1	1
			Odocoileus sp.	5	1	1
N205/W167 (Southern Extension)	38	full cut	*Sylvilagus audubonii* or *floridanus*	1	1	1
Feature 18, Pit D, N205/W167 (Southern Extension)	40	B	*Bison antiquus*	36	1	1
Pit E, N208/W167	41	B	*Bison antiquus*	2	1	1
Feature 19, Pit E, N208/W167	42	silt zone 4	*Bison* cf. *antiquus*	19	1	1
Pit F, N208/W173	42	full cut	large mammal (deer-sized, undetermined species)	2	1	1
			large mammal (undetermined species)	8	1	1
			large mammal (horse-bison size, undetermined species)	3	1	1

Horizontal Provenience	Stratum	Substratum	Taxon	NISP	MNI	MNE
	42	silt zone 2	*Equus* sp. (undetermined size)	1	1	1
			large mammal (undetermined species)	6	1	1
N208/W180	38	full cut	large mammal (undetermined species)	2	1	1
	42	full cut	*Bison antiquus*	5	1	1
			large mammal (undetermined species)	17	2	2
			large mammal (deer-sized, undetermined species)	1	1	1
			large mammal (*Bison*-sized, undetermined species)	7	2	2
	42	spall zone 3	*Bison antiquus*	2	1	1
N208/W185	38	full cut	large mammal (undetermined species)	8	1	1
	42	full cut	*Bison antiquus*	11	1	1
			large mammal (undetermined species)	6	2	2
	42	spall zone 1	Ariodactyla	3	2	2
			Bison antiquus	32	2	2
			Equus sp. (large size)	4	1	1
			large mammal (undetermined species)	24	2	2
			large mammal (deer-sized, undetermined species)	1	1	1
			large mammal (large deer-sized, undetermined species)	1	1	1
			large mammal (small horse size, undetermined species)	1	1	1
			large mammal (large horse-bison size, undetermined species)	1	1	1
N208/W190	42	full cut	*Equus* sp. (undetermined size)	1	1	1

Horizontal Provenience	Stratum	Substratum	Taxon	NISP	MNI	MNE
N210/W170-175	23	23D, full cut	medium mammal (undetermined species)	2	2	2
			large mammal (undetermined species)	1	1	1
	25	sand layer below stratum	*Odocoileus* sp.	7	1	1
N215/W170	3&4	mixed, full cut	Osteichthyes	62	2	2
			Lepisosteus sp.	2	1	1
			Ictalurus natalis	1	1	1
			Ictalurus sp.	6	3	3
			Aplodinotus grunniens	3	1	1
			Trionyx spiniferus	1	1	1
			Crotalidae	1	1	1
			Aves	2	1	1
			Falconiformes	1	1	1
			cf. *Colinus virginianus* or *Callipepla squamata*	1	1	1
			Odocoileus sp.	2	1	1
			Leporidae	34	4	4
			Lepus californicus	26	2	2
			cf. *Sylvilagus audobonii* or *floridanus*	81	14	14
			Castor canadensis	2	1	1
			Neotoma micropus	2	1	1
			Sigmodon hispidus	15	6	6

Horizontal Provenience	Stratum	Substratum	Taxon	NISP	MNI	MNE
			Spermophilus variegatus	3	2	2
			Canis latrans	3	1	1
			Canis cf. *familiaris* or *latrans*	1	1	1
			Procyon lotor	1	1	1
			carnivore (undetermined species)	4	1	1
			Mammalia	82	3	3
			large mammal (undetermined species)	11	2	2
N215/W170-175	23	23C, full cut	Mammalia	2	2	2

Table 5.3: NISP Values Aggregated by Regional Cultural Period.

Taxon	**NISP Historic/Late Prehistoric (Historic - Infierno - Flecha)**	**NISP Terminal Late Archaic (Blue Hills - Flanders)**	**NISP Earlier Late Archaic (Cibola)**	**NISP Middle Archaic (San Felipe - Eagle Nest)**	**NISP Early Archaic (Viejo)**	**NISP Paleo-indian**	**Composite NISP Totals by Taxon**
Osteichthyes	2	230	17		5		254
Scaphirhynchus platyrhynchus		1					1
Lepisosteus osseus		1					1
Lepisosteus cf. *spatula*		29					29
Lepisosteus sp.	9	116	9	3			137
Ictaluridae	2	98					100
Ictalurus furcatus	2	36	5	5			48
Ictalurus punctatus	1	12	6	3			22
Ictalurus punctatus or *mexicanus*		5					5
Ictalurus sp., subgenus *Ictulurus*		3	5				8
Ictalurus melas		1					1
Ictalurus natalis	2	1					3
Ictalurus sp.	15	98	17	3			133

Taxon	NISP Historic/Late Prehistoric (Historic - Infierno - Flecha)	NISP Terminal Late Archaic (Blue Hills - Flanders)	NISP Earlier Late Archaic (Cibola)	NISP Middle Archaic (San Felipe - Eagle Nest)	NISP Early Archaic (Viejo)	NISP Paleo-indian	Composite NISP Totals by Taxon
Pylodictis olivaris	3	171	22	5			201
Cypriformes		22	2				24
Catostomidae	11	50					61
Carpiodes carpio		29	5				34
Catostomus sp.		2					2
Cycleptus elongatus		26	3				29
Ictiobus niger	4	1	8				13
Ictiobus bubalus		6					6
Ictiobus sp.		154					154
Perciformes				1			1
Centrarchidae		8					8
Micropterus salmoides	1	4					5
Micropterus sp.		5					5
Morone chrysops		5					5
Aplodinotus grunniens		36	32				68

Taxon	NISP Historic/Late Prehistoric (Historic - Infierno - Flecha)	NISP Terminal Late Archaic (Blue Hills - Flanders)	NISP Earlier Late Archaic (Cibola)	NISP Middle Archaic (San Felipe - Eagle Nest)	NISP Early Archaic (Viejo)	NISP Paleo-indian	Composite NISP Totals by Taxon
Rana catesbiana			2				2
Rana pipiens		3					3
Chelonia		2					2
Testudinidae	1		1				2
Chelydra serpentina			1				1
Pseudemys sp.		1					1
Trionyx spiniferus	4	28	6	4			42
Pituophis sp.		1					1
Coluber constrictor or *Masticophis flagellum*		2					2
Crotalidae		1	1				2
Crotalus atrox			1				1
Crotalus sp.		1					1
Crotalus or *Agkistrodon* sp.		1					1
Agkistrodon contortrix	1	1					2
Aves		7					7

Taxon	NISP Historic/Late Prehistoric (Historic - Infierno - Flecha)	NISP Terminal Late Archaic (Blue Hills - Flanders)	NISP Earlier Late Archaic (Cibola)	NISP Middle Archaic (San Felipe - Eagle Nest)	NISP Early Archaic (Viejo)	NISP Paleo-indian	Composite NISP Totals by Taxon
Aves (undetermined large bird species)			3				3
Anatidae		1					1
Anatidae (size of *Aix sponsa)*		1					1
Anatidae (size of *Anas platyrhynchus*)		1					1
Aythya americana			2				2
Aythya sp.			1				1
cf. *Aythya* or *Melanitta* sp.			1				1
Anas platyrhynchus		1					1
Anas strepera				1			1
Anas cf. *discors* or *carolinensis*			1				1
Anas or *Branta* sp.			1				1
Branta canadensis		1					1
Chen sp.		1					1
Laridae			1				1

Taxon	NISP Historic/Late Prehistoric (Historic - Infierno - Flecha)	NISP Terminal Late Archaic (Blue Hills - Flanders)	NISP Earlier Late Archaic (Cibola)	NISP Middle Archaic (San Felipe - Eagle Nest)	NISP Early Archaic (Viejo)	NISP Paleo-indian	Composite NISP Totals by Taxon
Geococcyx californicus			1				1
Falconiformes		1					1
Accipitridae			1				1
Accipitridae (size similar to *Accipiter cooperi*)			1				1
Buteo cf. *jamaicensis*			1				1
Buteo cf. *lineatus*			1				1
Buteo cf. *lineatus* or *jamaicensis*		1					1
Buteo sp.		2	1				3
Falco cf. *sparverius*			1				1
Falco sp.		5					5
Ictinia cf. *mississippiensis*			1				1
Ictinia or *Falco* sp.			1				1
Colinus virginianus		17					17
cf. *Colinus virginianus* or *Callipepla squamata*		13	4				17

Taxon	NISP Historic/Late Prehistoric (Historic - Infierno - Flecha)	NISP Terminal Late Archaic (Blue Hills - Flanders)	NISP Earlier Late Archaic (Cibola)	NISP Middle Archaic (San Felipe - Eagle Nest)	NISP Early Archaic (Viejo)	NISP Paleo-indian	Composite NISP Totals by Taxon
Meleagris gallapavo		1					1
Zenaida asiatica		2					2
Mammalia (undetermined species)	1	623		5			629
Artiodactyla	3	35	1	21		3	63
Ariodactyla (large deer size)				1			1
Odocoileus cf. *hemionus*		6	1	10			17
Odocoileus virginianus	6	4	1				11
Odocoileus sp.	11	141	33	70	3		258
Antilocapra americana		7		3			10
cf. *Antilocapra americana*	2						2
Ovis sp.	1						1
Ovis or *Capra* sp.	15						15
Bison antiquus						88	88
Bison cf. *antiquus*						19	1
Bison bison		4					4

Taxon	NISP Historic/Late Prehistoric (Historic - Infierno - Flecha)	NISP Terminal Late Archaic (Blue Hills - Flanders)	NISP Earlier Late Archaic (Cibola)	NISP Middle Archaic (San Felipe - Eagle Nest)	NISP Early Archaic (Viejo)	NISP Paleo-indian	Composite NISP Totals by Taxon
Bison or *Bos* sp.	1						1
Equus sp. (large size)						4	4
Equus sp. (undetermined size)						2	2
Leporidae		42					42
Lepus californicus	10	362	51	6			429
Sylvilagus audubonii		1					1
Sylvilagus cf. *audubonii*		4	4	1			9
Sylvilagus cf. *floridanus*		2	1				3
Sylvilagus audubonii or *floridanus*	30	1090	155	26		1	1302
Rodentia		8					8
Castor canadensis	2	6	2	3			13
Ondatra zibethicus		9					9
Neotoma albigula	1	5		1			7
Neotoma cf. *albigula*	1		3				4
Neotoma cf. *floridana*			4				4

Taxon	NISP Historic/Late Prehistoric (Historic - Infierno - Flecha)	NISP Terminal Late Archaic (Blue Hills - Flanders)	NISP Earlier Late Archaic (Cibola)	NISP Middle Archaic (San Felipe - Eagle Nest)	NISP Early Archaic (Viejo)	NISP Paleo-indian	Composite NISP Totals by Taxon
Neotoma micropus		9					9
Neotoma sp.		9	3	1			13
Sigmodon hispidus	1	48	2				51
Geomys personatus		1					1
Pappogeomys castanops		1	1				2
Sciurus cf. *niger*			1				1
Spermophilus mexicanus		2					2
Spermophilus cf. *mexicanus*		1					1
Spermophilus variegatus		17	5				22
carnivore (undetermined species)		4					4
small carnivore (undetermined species)		1					1
large carnivore (undetermined species)		1					1
Canidae				1			1
small canid (undetermined species)		2					2

Taxon	NISP Historic/Late Prehistoric (Historic - Infierno - Flecha)	NISP Terminal Late Archaic (Blue Hills - Flanders)	NISP Earlier Late Archaic (Cibola)	NISP Middle Archaic (San Felipe - Eagle Nest)	NISP Early Archaic (Viejo)	NISP Paleo-indian	Composite NISP Totals by Taxon
Canis familiaris		3					3
Canis latrans		5					5
cf. *Canis latrans*			4				4
Canis cf. *familiaris* or *latrans*		23		7			30
Vulpes vulpes		1					1
Vulpes cf. *vulpes*		1					1
Vulpes velox		2	1				3
Vulpes cf. *velox*			1	1	1		3
Vulpes cf. *vulpes* or *velox*		1					1
Urocyon cinereoargenteus	3	11	2	1			17
large fox (undetermined species)		2	2				4
Lynx rufus			1				1
Spilogale sp.		4	1				5
large skunk (undetermined species)			1				1
Taxidea taxus		1					1

Taxon	NISP Historic/Late Prehistoric (Historic - Infierno - Flecha)	NISP Terminal Late Archaic (Blue Hills - Flanders)	NISP Earlier Late Archaic (Cibola)	NISP Middle Archaic (San Felipe - Eagle Nest)	NISP Early Archaic (Viejo)	NISP Paleo-indian	Composite NISP Totals by Taxon
Bassariscus astutus	1	11					12
Procyon lotor	2	8		7			17
Procyon cf. *lotor simus*		2					2
small mammal (undetermined species)			33	1			34
small – medium mammal (undetermined species)	1		1	2			4
medium mammal (undetermined species)	1		12	2			15
medium - large mammal (undetermined species)	1		2	3	3		9
large mammal (deer-sized, undetermined species)			1			4	5
large mammal (large deer-sized, undetermined species)						1	1
large mammal (small horse size, undetermined species)						1	1
large mammal (horse-bison size, undetermined species)						3	3

Taxon	NISP Historic/Late Prehistoric (Historic - Infierno - Flecha)	NISP Terminal Late Archaic (Blue Hills - Flanders)	NISP Earlier Late Archaic (Cibola)	NISP Middle Archaic (San Felipe - Eagle Nest)	NISP Early Archaic (Viejo)	NISP Paleo-indian	Composite NISP Totals by Taxon
large mammal (large horse-bison size, undetermined species)						1	1
large mammal (bison-sized, undetermined species)						7	7
large mammal (undetermined species)	12	20	14	4	1	71	122
Totals =	**162**	**3786**	**530**	**204**	**13**	**205**	**4900**

Table 5.4: NISP % Values Aggregated by Regional Cultural Period.

Taxon	**NISP % Historic/Late Prehistoric (Historic - Infierno - Flecha)**	**NISP % Terminal Late Archaic (Blue Hills - Flanders)**	**NISP % Earlier Late Archaic (Cibola)**	**NISP % Middle Archaic (San Felipe - Eagle Nest)**	**NISP % Early Archaic (Viejo)**	**NISP % Paleo-indian**	**Composite NISP % Totals by Taxon**
Osteichthyes	1.22	6.1	3.33		38.46		**5.24**
Scaphirhynchus platyrhynchus		<0.1					**<0.1**
Lepisosteus osseus		<0.1					**<0.1**
Lepisosteus cf. *spatula*		0.77					**0.59**
Lepisosteus sp.	5.49	3.1	1.76	1.49			**2.82**
Ictaluridae	1.22	2.59					**1.16**
Ictalurus furcatus	1.22	0.95	0.98	2.49			**0.99**
Ictalurus punctatus	0.61	0.32	1.17	1.49			**0.45**
Ictalurus punctatus or *mexicanus*		0.13					**0.1**
Ictalurus sp., subgenus *Ictulurus*		<0.1	0.98				**0.16**
Ictalurus melas		<0.1					**<0.1**
Ictalurus natalis	1.22	<0.1					**<0.1**

Taxon	NISP % Historic/Late Prehistoric (Historic - Infierno - Flecha)	NISP % Terminal Late Archaic (Blue Hills - Flanders)	NISP % Earlier Late Archaic (Cibola)	NISP % Middle Archaic (San Felipe - Eagle Nest)	NISP % Early Archaic (Viejo)	NISP % Paleo-indian	Composite NISP % Totals by Taxon
Ictalurus sp.	9.15	2.59	3.33	1.49			**2.74**
Pylodictis olivaris	1.83	4.52	4.31	2.49			**4.14**
Cypriformes		0.58	0.39				**0.49**
Catostomidae	6.71	1.32					**1.25**
Carpiodes carpio		0.77	0.98				**0.7**
Catostomus sp.		<0.1					**<0.1**
Cycleptus elongatus		0.69	0.59				**0.6**
Ictiobus niger	2.44	<0.1	1.57				**0.27**
Ictiobus bubalus		0.16					**0.12**
Ictiobus sp.		4.07					**3.16**
Perciformes				0.5			**<0.1**
Centrarchidae		0.21					**0.16**
Micropterus salmoides	0.61	0.1					**0.1**
Micropterus sp.		0.13					**0.1**
Morone chrysops		0.13					**0.1**
Aplodinotus grunniens		0.95	6.27				**1.4**

Taxon	**NISP % Historic/Late Prehistoric (Historic - Infierno - Flecha)**	**NISP % Terminal Late Archaic (Blue Hills - Flanders)**	**NISP % Earlier Late Archaic (Cibola)**	**NISP % Middle Archaic (San Felipe - Eagle Nest)**	**NISP % Early Archaic (Viejo)**	**NISP % Paleo-indian**	**Composite NISP % Totals by Taxon**
Rana catesbiana			0.39				**<0.1**
Rana pipiens		<0.1					**<0.1**
Chelonia		<0.1					**<0.1**
Testudinidae	0.61		0.19				**<0.1**
Chelydra serpentina			0.19				**<0.1**
Pseudemys sp.		<0.1					**<0.1**
Trionyx spiniferus	2.44	0.74	1.18	1.99			**0.86**
Pituophis sp.		<0.1					**<0.1**
Coluber constrictor or *Masticophis flagellum*		<0.1					**<0.1**
Crotalidae		<0.1	0.19				**<0.1**
Crotalus atrox			0.19				**<0.1**
Crotalus sp.		<0.1					**<0.1**
Crotalus or *Agkistrodon* sp.		<0.1					**<0.1**
Agkistrodon contortrix	0.61	<0.1					**<0.1**
Aves		0.18					**0.14**

Taxon	NISP % Historic/Late Prehistoric (Historic - Infierno - Flecha)	NISP % Terminal Late Archaic (Blue Hills - Flanders)	NISP % Earlier Late Archaic (Cibola)	NISP % Middle Archaic (San Felipe - Eagle Nest)	NISP % Early Archaic (Viejo)	NISP % Paleo-indian	Composite NISP % Totals by Taxon
Aves (undetermined large bird species)			0.59				**<0.1**
Anatidae		<0.1					**<0.1**
Anatidae (size of *Aix sponsa)*		<0.1					**<0.1**
Anatidae (size of *Anas platyrhynchus*)		<0.1					**<0.1**
Aythya americana			0.39				**<0.1**
Aythya sp.			0.19				**<0.1**
cf. *Aythya* or *Melanitta* sp.			0.19				**<0.1**
Anas platyrhynchus		<0.1					**<0.1**
Anas strepera				0.5			**<0.1**
Anas cf. *discors* or *carolinensis*			0.19				**<0.1**
Anas or *Branta* sp.			0.19				**<0.1**
Branta canadensis		<0.1					**<0.1**
Chen sp.		<0.1					**<0.1**
Laridae			0.19				**<0.1**
Geococcyx californicus			0.19				**<0.1**

Taxon	**NISP % Historic/Late Prehistoric (Historic - Infierno - Flecha)**	**NISP % Terminal Late Archaic (Blue Hills - Flanders)**	**NISP % Earlier Late Archaic (Cibola)**	**NISP % Middle Archaic (San Felipe - Eagle Nest)**	**NISP % Early Archaic (Viejo)**	**NISP % Paleo-indian**	**Composite NISP % Totals by Taxon**
Falconiformes		<0.1					**<0.1**
Accipitridae			0.19				**<0.1**
Accipitridae (size similar to *Accipiter cooperi*)			0.19				**<0.1**
Buteo cf. *jamaicensis*			0.19				**<0.1**
Buteo cf. *lineatus*			0.19				**<0.1**
Buteo cf. *lineatus* or *jamaicensis*		<0.1					**<0.1**
Buteo sp.		<0.1	0.19				**<0.1**
Falco cf. *sparverius*			0.19				**<0.1**
Falco sp.		0.13					**0.1**
Ictinia cf. *mississippiensis*			0.19				**<0.1**
Ictinia or *Falco* sp.			0.19				**<0.1**
Colinus virginianus		0.45					**0.35**
cf. *Colinus virginianus* or *Callipepla squamata*		0.34	0.78				**0.35**
Meleagris gallapavo		<0.1					**<0.1**

Taxon	**NISP % Historic/Late Prehistoric (Historic - Infierno - Flecha)**	**NISP % Terminal Late Archaic (Blue Hills - Flanders)**	**NISP % Earlier Late Archaic (Cibola)**	**NISP % Middle Archaic (San Felipe - Eagle Nest)**	**NISP % Early Archaic (Viejo)**	**NISP % Paleo-indian**	**Composite NISP % Totals by Taxon**
Zenaida asiatica		<0.1					**<0.1**
Mammalia (undetermined species)	0.61	16.4		2.49			**12.94**
Artiodactyla	1.83	0.92	0.19	10.44		1.6	**1.3**
Ariodactyla (large deer size)				0.5			**<0.1**
Odocoileus cf. *hemionus*		0.16	0.19	4.98			**0.35**
Odocoileus virginianus	3.66	0.1	0.19				**0.23**
Odocoileus sp.	6.71	3.73	6.47	34.8	23.08		**5.3**
Antilocapra americana		0.18		1.49			**0.2**
cf. *Antilocapra americana*	1.22						**<0.1**
Ovis sp.	0.61						**<0.1**
Ovis or *Capra* sp.	9.15						**0.31**
Bison antiquus						47.0	**1.81**
Bison cf. *antiquus*						0.53	**<0.1**
Bison bison		0.1					**<0.1**
Bison or *Bos* sp.	0.61						**<0.1**

Taxon	NISP % Historic/Late Prehistoric (Historic - Infierno - Flecha)	NISP % Terminal Late Archaic (Blue Hills - Flanders)	NISP % Earlier Late Archaic (Cibola)	NISP % Middle Archaic (San Felipe - Eagle Nest)	NISP % Early Archaic (Viejo)	NISP % Paleo-indian	Composite NISP % Totals by Taxon
Equus sp. (large size)						2.14	**<0.1**
Equus sp. (undetermined size)						1.07	**<0.1**
Leporidae		1.11					**0.86**
Lepus californicus	6.1	9.6	10.0	2.98			**8.83**
Sylvilagus audubonii		<0.1					**<0.1**
Sylvilagus cf. *audubonii*		<0.1	0.78	0.5			**0.18**
Sylvilagus cf. *floridanus*		<0.1	0.19				**<0.1**
Sylvilagus audubonii or *floridanus*	18.3	28.8	30.39	12.94		0.53	**26.79**
Rodentia		0.21					**0.16**
Castor canadensis	1.22	0.16	0.39	1.49			**0.27**
Ondatra zibethicus		0.24					**0.18**
Neotoma albigula	0.61	0.13		0.5			**0.14**
Neotoma cf. *albigula*	0.61		0.59				**<0.1**
Neotoma cf. *floridana*			0.78				**<0.1**
Neotoma micropus		0.24					**0.18**

Taxon	NISP % Historic/Late Prehistoric (Historic - Infierno - Flecha)	NISP % Terminal Late Archaic (Blue Hills - Flanders)	NISP % Earlier Late Archaic (Cibola)	NISP % Middle Archaic (San Felipe - Eagle Nest)	NISP % Early Archaic (Viejo)	NISP % Paleo-indian	Composite NISP % Totals by Taxon
Neotoma sp.		0.24	0.59	0.5			**0.27**
Sigmodon hispidus	0.61	1.27	0.39				**1.05**
Geomys personatus		<0.1					**<0.1**
Pappogeomys castanops		<0.1	0.19				**<0.1**
Sciurus cf. *niger*			0.19				**<0.1**
Spermophilus mexicanus		<0.1					**<0.1**
Spermophilus cf. *mexicanus*		<0.1					**<0.1**
Spermophilus variegatus		0.45	0.98				**0.45**
carnivore (undetermined species)		0.1					**<0.1**
small carnivore (undetermined species)		<0.1					**<0.1**
large carnivore (undetermined species)		<0.1					**<0.1**
Canidae				0.5			**<0.1**
small canid (undetermined species)		<0.1					**<0.1**
Canis familiaris		<0.1					**<0.1**

Taxon	**NISP % Historic/Late Prehistoric (Historic - Infierno - Flecha)**	**NISP % Terminal Late Archaic (Blue Hills - Flanders)**	**NISP % Earlier Late Archaic (Cibola)**	**NISP % Middle Archaic (San Felipe - Eagle Nest)**	**NISP % Early Archaic (Viejo)**	**NISP % Paleo-indian**	**Composite NISP % Totals by Taxon**
Canis latrans		0.13					**0.1**
cf. *Canis latrans*			0.78				**<0.1**
Canis cf. *familiaris* or *latrans*		0.61		3.48			**0.62**
Vulpes vulpes		<0.1					**<0.1**
Vulpes cf. *vulpes*		<0.1					**<0.1**
Vulpes velox		<0.1	0.19				**<0.1**
Vulpes cf. *velox*			0.19	0.5	7.69		**<0.1**
Vulpes cf. *vulpes* or *velox*		<0.1					**<0.1**
Urocyon cinereoargenteus	1.83	0.29	0.39	0.5			**0.35**
large fox (undetermined species)		<0.1	0.39				**<0.1**
Lynx rufus			0.19				**<0.1**
Spilogale sp.		<0.1	0.19				**<0.1**
large skunk (undetermined species)			0.19				**<0.1**
Taxidea taxus		<0.1					**<0.1**
Bassariscus astutus	0.61	<0.1					**0.25**

Taxon	NISP % Historic/Late Prehistoric (Historic - Infierno - Flecha)	NISP % Terminal Late Archaic (Blue Hills - Flanders)	NISP % Earlier Late Archaic (Cibola)	NISP % Middle Archaic (San Felipe - Eagle Nest)	NISP % Early Archaic (Viejo)	NISP % Paleo-indian	Composite NISP % Totals by Taxon
Procyon lotor	1.22	0.21		3.48			**0.35**
Procyon cf. *lotor simus*		<0.1					**<0.1**
small mammal (undetermined species)			6.47	0.5			**0.7**
small – medium mammal (undetermined species)	0.61		0.19	0.99			**<0.1**
medium mammal (undetermined species)	0.61		2.35	0.99			**0.31**
medium - large mammal (undetermined species)	0.61		0.39	1.49	23.08		**0.18**
large mammal (deer-sized, undetermined species)			0.19			2.14	**0.1**
large mammal (large deer-sized, undetermined species)						0.53	**<0.1**
large mammal (small horse size, undetermined species)						0.53	**<0.1**
large mammal (horse-bison size, undetermined species)						1.49	**<0.1**
large mammal (large horse-bison size, undetermined						0.53	**<0.1**

Taxon	NISP % Historic/Late Prehistoric (Historic - Infierno - Flecha)	NISP % Terminal Late Archaic (Blue Hills - Flanders)	NISP % Earlier Late Archaic (Cibola)	NISP % Middle Archaic (San Felipe - Eagle Nest)	NISP % Early Archaic (Viejo)	NISP % Paleo-indian	Composite NISP % Totals by Taxon
species)							
large mammal (bison-sized, undetermined species)						3.74	**0.14**
large mammal (undetermined species)	8.57	0.53	2.74	1.99	7.69	37.97	**2.5**
Totals ≈	**100**	**100**	**100**	**100**	**100**	**100**	**100**

Table 5.5: MNI Values Aggregated by Regional Cultural Period.

Taxon	**MNI Historic/Late Prehistoric (Historic - Infierno - Flecha)**	**MNI Terminal Late Archaic (Blue Hills - Flanders)**	**MNI Earlier Late Archaic (Cibola)**	**MNI Middle Archaic (San Felipe - Eagle Nest)**	**MNI Early Archaic (Viejo)**	**MNI Paleo-indian**	**Composite MNI Totals by Taxon**
Osteichthyes	1	14	3		2		20
Scaphirhynchus platyrhynchus		1	1				2
Lepisosteus osseus		1					1
Lepisosteus cf. *spatula*		1					1
Lepisosteus sp.	4	15	5	2			26
Ictaluridae		7					7
Ictalurus furcatus	1	30	3	4			38
Ictalurus punctatus	1	8	4	2			15
Ictalurus punctatus or *mexicanus*		3					3
Ictalurus sp., subgenus *Ictulurus*		3	1				4
Ictalurus melas		1					1
Ictalurus natalis		1					1
Ictalurus sp.	4	29	3	3			39

Taxon	**MNI Historic/Late Prehistoric (Historic - Infierno - Flecha)**	**MNI Terminal Late Archaic (Blue Hills - Flanders)**	**MNI Earlier Late Archaic (Cibola)**	**MNI Middle Archaic (San Felipe - Eagle Nest)**	**MNI Early Archaic (Viejo)**	**MNI Paleo-indian**	**Composite MNI Totals by Taxon**
Pylodictis olivaris	2	31	6	2			41
Cypriformes		6	2				8
Catostomidae	3	7					10
Carpiodes carpio		9	2				11
Catostomus sp.		1					1
Cycleptus elongatus		9	1				10
Ictiobus niger	2	1	5				8
Ictiobus bubalus		3					3
Ictiobus sp.		13					13
Perciformes				2			2
Centrarchidae		1					2
Micropterus salmoides	1	2					3
Micropterus sp.		1					1
Morone chrysops		3					3
Aplodinotus grunniens		6	6				12
Rana catesbiana			1				1

Taxon	MNI Historic/Late Prehistoric (Historic - Infierno - Flecha)	MNI Terminal Late Archaic (Blue Hills - Flanders)	MNI Earlier Late Archaic (Cibola)	MNI Middle Archaic (San Felipe - Eagle Nest)	MNI Early Archaic (Viejo)	MNI Paleo-indian	Composite MNI Totals by Taxon
Rana pipiens		2					2
Chelonia		1					1
Testudinidae	1		1				2
Chelydra serpentina			1				1
Pseudemys sp.		1					1
Trionyx spiniferus	3	8	3	3			17
Pituophis sp.		1					1
Coluber constrictor or *Masticophis flagellum*		1					1
Crotalidae		1	1				2
Crotalus atrox			1				1
Crotalus sp.		1					1
Crotalus or *Agkistrodon* sp.		1					1
Agkistrodon contortrix	2	1					3
Aves		3					3
Aves (undetermined large bird			2				2

Taxon	MNI Historic/Late Prehistoric (Historic - Infierno - Flecha)	MNI Terminal Late Archaic (Blue Hills - Flanders)	MNI Earlier Late Archaic (Cibola)	MNI Middle Archaic (San Felipe - Eagle Nest)	MNI Early Archaic (Viejo)	MNI Paleo-indian	Composite MNI Totals by Taxon
species)							
Anatidae		1					1
Anatidae (size of *Aix sponsa)*		1					1
Anatidae (size of *Anas platyrhynchus*)		1					1
Aythya americana			1				1
Aythya sp.			1				1
cf. *Aythya* or *Melanitta* sp.			1				1
Anas platyrhynchus		1					1
Anas strepera				1			1
Anas cf. *discors* or *carolinensis*			1				1
Anas or *Branta* sp.			1				1
Branta canadensis		1					1
Chen sp.		1					1
Laridae			1				1
Geococcyx californicus			1				1

Taxon	MNI Historic/Late Prehistoric (Historic - Infierno - Flecha)	MNI Terminal Late Archaic (Blue Hills - Flanders)	MNI Earlier Late Archaic (Cibola)	MNI Middle Archaic (San Felipe - Eagle Nest)	MNI Early Archaic (Viejo)	MNI Paleo-indian	Composite MNI Totals by Taxon
Falconiformes		1					1
Accipitridae			1				1
Accipitridae (size similar to *Accipiter cooperi*)			1				1
Buteo cf. *jamaicensis*			1				1
Buteo cf. *lineatus*			1				1
Buteo cf. *lineatus* or *jamaicensis*		1					1
Buteo sp.		2	1				3
Falco cf. *sparverius*			1				1
Falco sp.		1					1
Ictinia cf. *mississippiensis*			1				1
Ictinia or *Falco* sp.			1				1
Colinus virginianus		13	7				20
cf. *Colinus virginianus* or *Callipepla squamata*		6	1				7
Meleagris gallapavo		1					1

Taxon	MNI Historic/Late Prehistoric (Historic - Infierno - Flecha)	MNI Terminal Late Archaic (Blue Hills - Flanders)	MNI Earlier Late Archaic (Cibola)	MNI Middle Archaic (San Felipe - Eagle Nest)	MNI Early Archaic (Viejo)	MNI Paleo-indian	Composite MNI Totals by Taxon
Zenaida asiatica		1					1
Mammalia (undetermined species)	1	6		3			10
Artiodactyla	2	4	1	4		2	13
Ariodactyla (large deer size)				1			1
Odocoileus cf. *hemionus*		3	1	6			10
Odocoileus virginianus	1	2	1				4
Odocoileus sp.	2	17	6	16	1		42
Antilocapra americana		3	3	2			8
cf. *Antilocapra americana*	1						1
Ovis sp.	1						1
Ovis or *Capra* sp.	2						2
Bison antiquus						7	7
Bison cf. *antiquus*						1	1
Bison bison		2					2
Bison or *Bos* sp.	1						1

Taxon	MNI Historic/Late Prehistoric (Historic - Infierno - Flecha)	MNI Terminal Late Archaic (Blue Hills - Flanders)	MNI Earlier Late Archaic (Cibola)	MNI Middle Archaic (San Felipe - Eagle Nest)	MNI Early Archaic (Viejo)	MNI Paleo-indian	Composite MNI Totals by Taxon
Equus sp. (large size)						1	1
Equus sp. (undetermined size)						2	2
Leporidae		10					10
Lepus californicus	5	61	15	3			84
Sylvilagus audubonii		1					1
Sylvilagus cf. *audubonii*		2	2	1			5
Sylvilagus cf. *floridanus*		2	1				3
Sylvilagus audubonii or *floridanus*	8	127	21	11		1	168
Rodentia		2		1			3
Castor canadensis	2	5	2	2			11
Ondatra zibethicus		7					7
Neotoma albigula	1	4		1			6
Neotoma cf. *albigula*	1		3				4
Neotoma cf. *floridana*			3				3
Neotoma micropus		2					2

Taxon	MNI Historic/Late Prehistoric (Historic - Infierno - Flecha)	MNI Terminal Late Archaic (Blue Hills - Flanders)	MNI Earlier Late Archaic (Cibola)	MNI Middle Archaic (San Felipe - Eagle Nest)	MNI Early Archaic (Viejo)	MNI Paleo-indian	Composite MNI Totals by Taxon
Neotoma sp.		7	1	1			9
Sigmodon hispidus	1	28	2				31
Geomys personatus		1					1
Pappogeomys castanops		1	1				2
Sciurus cf. *niger*			1				1
Spermophilus mexicanus		2					2
Spermophilus cf. *mexicanus*		1					1
Spermophilus variegatus		12	4				16
carnivore (undetermined species)		1					1
small carnivore (undetermined species)		1					1
large carnivore (undetermined species)		1					1
Canidae				1			1
small canid (undetermined species)		2		1			3
Canis familiaris		1					1

Taxon	MNI Historic/Late Prehistoric (Historic - Infierno - Flecha)	MNI Terminal Late Archaic (Blue Hills - Flanders)	MNI Earlier Late Archaic (Cibola)	MNI Middle Archaic (San Felipe - Eagle Nest)	MNI Early Archaic (Viejo)	MNI Paleo-indian	Composite MNI Totals by Taxon
Canis latrans		3					3
cf. *Canis latrans*			2				2
Canis cf. *familiaris* or *latrans*		6		2			8
Vulpes vulpes		1					1
Vulpes cf. *vulpes*		1					1
Vulpes velox		1	1				2
Vulpes cf. *velox*			1	1	1		3
Vulpes cf. *vulpes* or *velox*		1					1
Urocyon cinereoargenteus	3	9	2	1			15
large fox (undetermined species)		2	2				4
Lynx rufus			1				1
Spilogale sp.		4	1				5
large skunk (undetermined species)			1				1
Taxidea taxus		1					1
Bassariscus astutus	1	7	3				11

Taxon	MNI Historic/Late Prehistoric (Historic - Infierno - Flecha)	MNI Terminal Late Archaic (Blue Hills - Flanders)	MNI Earlier Late Archaic (Cibola)	MNI Middle Archaic (San Felipe - Eagle Nest)	MNI Early Archaic (Viejo)	MNI Paleo-indian	Composite MNI Totals by Taxon
Procyon lotor	2	7		2			11
Procyon cf. *lotor simus*		2					2
small mammal (undetermined species)			4	1			5
small – medium mammal (undetermined species)	1		1	1			3
medium mammal (undetermined species)	1		2	2			5
medium - large mammal (undetermined species)			1	1	1		3
large mammal (deer-sized, undetermined species)			1			3	3
large mammal (large deer-sized, undetermined species)						1	1
large mammal (small horse size, undetermined species)						1	1
large mammal (horse-bison size, undetermined species)						1	1

Taxon	MNI Historic/Late Prehistoric (Historic - Infierno - Flecha)	MNI Terminal Late Archaic (Blue Hills - Flanders)	MNI Earlier Late Archaic (Cibola)	MNI Middle Archaic (San Felipe - Eagle Nest)	MNI Early Archaic (Viejo)	MNI Paleo-indian	Composite MNI Totals by Taxon
large mammal (large horse-bison size, undetermined species)						1	1
large mammal (Bison-sized, undetermined species)						2	2
large mammal (undetermined species)	4	5	6	4	1	10	30
Totals =	**74**	**628**	**166**	**83**	**6**	**33**	**990**

Table 5.6: MNI % Values Aggregated by Regional Cultural Period.

Taxon	**MNI % Historic/Late Prehistoric (Historic - Infierno - Flecha)**	**MNI % Terminal Late Archaic (Blue Hills - Flanders**	**MNI % Earlier Late Archaic (Cibola)**	**MNI % Middle Archaic (San Felipe - Eagle Nest)**	**MNI % Early Archaic (Viejo)**	**MNI % Paleo-indian**	**Composite MNI % Totals by Taxon**
Osteichthyes	1.59	2.25	1.76		33.3		**2.04**
Scaphirhynchus platyrhynchus		0.16	0.59				**0.2**
Lepisosteus osseus		0.16					**0.1**
Lepisosteus cf. *spatula*		0.16					**0.1**
Lepisosteus sp.	6.35	2.4	2.94	2.3			**2.65**
Ictaluridae		1.12					**0.71**
Ictalurus furcatus	1.6	4.8	1.76	4.6			**3.87**
Ictalurus punctatus	1.6	1.29	2.35	2.3			**1.53**
Ictalurus punctatus or *mexicanus*		0.5					**0.3**
Ictalurus sp., subgenus *Ictulurus*		0.5	0.59				**0.4**
Ictalurus melas		0.16					**0.1**
Ictalurus natalis		0.16					**0.1**
Ictalurus sp.	6.35	4.7	1.76	3.5			**3.98**

Taxon	MNI % Historic/Late Prehistoric (Historic - Infierno - Flecha)	MNI % Terminal Late Archaic (Blue Hills - Flanders	MNI % Earlier Late Archaic (Cibola)	MNI % Middle Archaic (San Felipe - Eagle Nest)	MNI % Early Archaic (Viejo)	MNI % Paleo-indian	Composite MNI % Totals by Taxon
Pylodictis olivaris	3.17	4.98	3.53	2.3			**4.18**
Cypriformes		0.96	1.18				**0.82**
Catostomidae	4.76	1.12					**1.02**
Carpiodes carpio		1.44	1.18				**1.12**
Catostomus sp.		0.16					**0.1**
Cycleptus elongatus		1.44	0.59				**1.02**
Ictiobus niger	3.17	0.16	2.94				**0.82**
Ictiobus bubalus		0.5					**0.3**
Ictiobus sp.		2.09					**1.33**
Perciformes				2.3			**0.2**
Centrarchidae		0.16					**0.2**
Micropterus salmoides	1.6	0.32					**0.3**
Micropterus sp.		0.16					**0.1**
Morone chrysops		0.5					**0.3**
Aplodinotus grunniens		0.96	3.53				**1.22**
Rana catesbiana			0.59				**0.1**

Taxon	**MNI % Historic/Late Prehistoric (Historic - Infierno - Flecha)**	**MNI % Terminal Late Archaic (Blue Hills - Flanders**	**MNI % Earlier Late Archaic (Cibola)**	**MNI % Middle Archaic (San Felipe - Eagle Nest)**	**MNI % Early Archaic (Viejo)**	**MNI % Paleo-indian**	**Composite MNI % Totals by Taxon**
Rana pipiens		0.32					**0.2**
Chelonia		0.16					**0.1**
Testudinidae	1.6		0.59				**0.2**
Chelydra serpentina			0.59				**0.1**
Pseudemys sp.		0.16					**0.1**
Trionyx spiniferus	4.76	1.29	1.76	3.5			**1.7**
Pituophis sp.		0.16					**0.1**
Coluber constrictor or *Masticophis flagellum*		0.16					**0.1**
Crotalidae		0.16	0.59				**0.2**
Crotalus atrox			0.59				**0.1**
Crotalus sp.		0.16					**0.1**
Crotalus or *Agkistrodon* sp.		0.16					**0.1**
Agkistrodon contortrix	1.6	0.16					**0.3**
Aves		0.5					**0.3**
Aves (undetermined large bird			1.18				**0.2**

Taxon	**MNI % Historic/Late Prehistoric (Historic - Infierno - Flecha)**	**MNI % Terminal Late Archaic (Blue Hills - Flanders**	**MNI % Earlier Late Archaic (Cibola)**	**MNI % Middle Archaic (San Felipe - Eagle Nest)**	**MNI % Early Archaic (Viejo)**	**MNI % Paleo-indian**	**Composite MNI % Totals by Taxon**
species)							
Anatidae		0.16					**0.1**
Anatidae (size of *Aix sponsa)*		0.16					**0.1**
Anatidae (size of *Anas platyrhynchus*)		0.16					**0.1**
Aythya americana			0.59				**0.1**
Aythya sp.			0.59				**0.1**
cf. *Aythya* or *Melanitta* sp.			0.59				**0.1**
Anas platyrhynchus		0.16					**0.1**
Anas strepera				1.16			**0.1**
Anas cf. *discors* or *carolinensis*			0.59				**0.1**
Anas or *Branta* sp.			0.59				**0.1**
Branta canadensis		0.16					**0.1**
Chen sp.		0.16					**0.1**
Laridae			0.59				**0.1**
Geococcyx californicus			0.59				**0.1**

Taxon	MNI % Historic/Late Prehistoric (Historic - Infierno - Flecha)	MNI % Terminal Late Archaic (Blue Hills - Flanders	MNI % Earlier Late Archaic (Cibola)	MNI % Middle Archaic (San Felipe - Eagle Nest)	MNI % Early Archaic (Viejo)	MNI % Paleo-indian	Composite MNI % Totals by Taxon
Falconiformes		0.16					**0.1**
Accipitridae			0.59				**0.1**
Accipitridae (size similar to *Accipiter cooperi*)			0.59				**0.1**
Buteo cf. *jamaicensis*			0.59				**0.1**
Buteo cf. *lineatus*			0.59				**0.1**
Buteo cf. *lineatus* or *jamaicensis*		0.16					**0.1**
Buteo sp.		0.32	0.59				**0.3**
Falco cf. *sparverius*			0.59				**0.1**
Falco sp.		0.16					**0.1**
Ictinia cf. *mississippiensis*			0.59				**0.1**
Ictinia or *Falco* sp.			0.59				**0.1**
Colinus virginianus		2.09	4.12				**2.04**
cf. *Colinus virginianus* or *Callipepla squamata*		0.96	0.59				**0.71**
Meleagris gallapavo		0.16					**0.1**

Taxon	**MNI % Historic/Late Prehistoric (Historic - Infierno - Flecha)**	**MNI % Terminal Late Archaic (Blue Hills - Flanders**	**MNI % Earlier Late Archaic (Cibola)**	**MNI % Middle Archaic (San Felipe - Eagle Nest)**	**MNI % Early Archaic (Viejo)**	**MNI % Paleo-indian**	**Composite MNI % Totals by Taxon**
Zenaida asiatica		0.16					**0.1**
Mammalia (undetermined species)	1.6	0.96		3.5			**1.02**
Artiodactyla	3.17	0.64	0.59	4.65		6.06	**1.33**
Ariodactyla (large deer size)				1.16			**0.1**
Odocoileus cf. *hemionus*		0.5	0.59	6.98			**1.02**
Odocoileus virginianus	1.6	0.32	0.59				**0.41**
Odocoileus sp.	3.17	5.1	3.5	18.6	16.7		**4.3**
Antilocapra americana		0.5	1.76	2.3			**0.82**
cf. *Antilocapra americana*	1.6						**0.1**
Ovis sp.	1.6						**0.1**
Ovis or *Capra* sp.	3.17						**0.2**
Bison antiquus						21.21	**0.7**
Bison cf. *antiquus*						3.03	**0.1**
Bison bison		0.32					**0.2**
Bison or *Bos* sp.	1.6						**0.1**

Taxon	MNI % Historic/Late Prehistoric (Historic - Infierno - Flecha)	MNI % Terminal Late Archaic (Blue Hills - Flanders	MNI % Earlier Late Archaic (Cibola)	MNI % Middle Archaic (San Felipe - Eagle Nest)	MNI % Early Archaic (Viejo)	MNI % Paleo-indian	Composite MNI % Totals by Taxon
Equus sp. (large size)						3.03	**0.1**
Equus sp. (undetermined size)						6.06	**0.2**
Leporidae		1.6					**1.02**
Lepus californicus	7.9	9.8	8.8	3.5			**8.57**
Sylvilagus audubonii		0.16					**0.1**
Sylvilagus cf. *audubonii*		0.32	1.18	1.16			**0.5**
Sylvilagus cf. *floridanus*		0.32	0.59				**0.3**
Sylvilagus audubonii or *floridanus*	12.7	20.4	12.35	12.8		3.03	**17.14**
Rodentia		0.32		1.16			**0.3**
Castor canadensis	3.17	0.8	1.18	2.3			**1.1**
Ondatra zibethicus		1.12					**0.7**
Neotoma albigula	1.6	0.64		1.16			**0.6**
Neotoma cf. *albigula*	1.6		1.76				**0.4**
Neotoma cf. *floridana*			1.76				**0.3**
Neotoma micropus		0.32					**0.2**

Taxon	**MNI % Historic/Late Prehistoric (Historic - Infierno - Flecha)**	**MNI % Terminal Late Archaic (Blue Hills - Flanders**	**MNI % Earlier Late Archaic (Cibola)**	**MNI % Middle Archaic (San Felipe - Eagle Nest)**	**MNI % Early Archaic (Viejo)**	**MNI % Paleo-indian**	**Composite MNI % Totals by Taxon**
Neotoma sp.		1.12	0.59	1.16			**0.92**
Sigmodon hispidus	1.6	4.5	1.18				**3.16**
Geomys personatus		0.16					**0.1**
Pappogeomys castanops		0.16	0.59				**0.2**
Sciurus cf. *niger*			0.59				**0.1**
Spermophilus mexicanus		0.32					**0.2**
Spermophilus cf. *mexicanus*		0.16					**0.1**
Spermophilus variegatus		1.93	2.35				**1.63**
carnivore (undetermined species)		0.16					**0.1**
small carnivore (undetermined species)		0.16					**0.1**
large carnivore (undetermined species)		0.16					**0.1**
Canidae				1.16			**0.1**
small canid (undetermined species)		0.32		1.16			**0.3**
Canis familiaris		0.16					**0.1**

Taxon	MNI % Historic/Late Prehistoric (Historic - Infierno - Flecha)	MNI % Terminal Late Archaic (Blue Hills - Flanders	MNI % Earlier Late Archaic (Cibola)	MNI % Middle Archaic (San Felipe - Eagle Nest)	MNI % Early Archaic (Viejo)	MNI % Paleo-indian	Composite MNI % Totals by Taxon
Canis latrans		0.5					**0.3**
cf. *Canis latrans*			1.18				**0.2**
Canis cf. *familiaris* or *latrans*		0.96		2.3			**0.8**
Vulpes vulpes		0.16					**0.1**
Vulpes cf. *vulpes*		0.16					**0.1**
Vulpes velox		0.16	0.59				**0.2**
Vulpes cf. *velox*			0.59	1.16	16.7		**0.3**
Vulpes cf. *vulpes* or *velox*		0.16					**0.1**
Urocyon cinereoargenteus	4.76	1.44	1.18	1.16			**1.53**
large fox (undetermined species)		0.32	1.18				**0.4**
Lynx rufus			0.59				**0.1**
Spilogale sp.		0.64	0.59				**0.6**
large skunk (undetermined species)			0.59				**0.1**
Taxidea taxus		0.16					**0.1**
Bassariscus astutus	1.6	1.12	1.76				**1.12**

Taxon	MNI % Historic/Late Prehistoric (Historic - Infierno - Flecha)	MNI % Terminal Late Archaic (Blue Hills - Flanders	MNI % Earlier Late Archaic (Cibola)	MNI % Middle Archaic (San Felipe - Eagle Nest)	MNI % Early Archaic (Viejo)	MNI % Paleo-indian	Composite MNI % Totals by Taxon
Procyon lotor	3.17	1.12		2.3			**1.12**
Procyon cf. *lotor simus*		0.32					**0.2**
small mammal (undetermined species)			2.35	1.16			**0.5**
small – medium mammal (undetermined species)	1.6		0.59	1.16			**0.3**
medium mammal (undetermined species)	1.6		1.18	2.3			**0.5**
medium - large mammal (undetermined species)			0.59	1.16	16.7		**0.3**
large mammal (deer-sized, undetermined species)			0.59			9.09	**0.3**
large mammal (large deer-sized, undetermined species)						3.03	**0.1**
large mammal (small horse size, undetermined species)						3.03	**0.1**
large mammal (horse-bison size, undetermined species)						3.03	**0.1**

Taxon	MNI % Historic/Late Prehistoric (Historic - Infierno - Flecha)	MNI % Terminal Late Archaic (Blue Hills - Flanders	MNI % Earlier Late Archaic (Cibola)	MNI % Middle Archaic (San Felipe - Eagle Nest)	MNI % Early Archaic (Viejo)	MNI % Paleo-indian	Composite MNI % Totals by Taxon
large mammal (large horse-bison size, undetermined species)						3.03	**0.1**
large mammal (bison-sized, undetermined species)						6.06	**0.2**
large mammal (undetermined species)	6.35	0.8	3.53	4.65	16.7	30.3	**3.06**
Totals ≈	**100**	**100**	**100**	**100**	**100**	**100**	**100**

Table 5.7: MNE Values Aggregated by Regional Cultural Period

Taxon	MNE Historic/Late Prehistoric (Historic - Infierno - Flecha)	MNE Terminal Late Archaic (Blue Hills - Flanders)	MNE Earlier Late Archaic (Cibola)	MNE Middle Archaic (San Felipe - Eagle Nest)	MNE Early Archaic (Viejo)	MNE Paleo-indian	Composite MNE Totals by Taxon
Osteichthyes	1	14	3		2		20
Scaphirhynchus platyrhynchus		1	1				2
Lepisosteus osseus		1					1
Lepisosteus cf. *spatula*		1					1
Lepisosteus sp.	4	15	5	2			26
Ictaluridae		7					7
Ictalurus furcatus	1	30	3	4			38
Ictalurus punctatus	1	8	4	2			15
Ictalurus punctatus or *mexicanus*		3					3
Ictalurus sp., subgenus *Ictulurus*		3	1				4
Ictalurus melas		1					1
Ictalurus natalis		1					1
Ictalurus sp.	4	29	3	3			39

Taxon	MNE Historic/Late Prehistoric (Historic - Infierno - Flecha)	MNE Terminal Late Archaic (Blue Hills - Flanders)	MNE Earlier Late Archaic (Cibola)	MNE Middle Archaic (San Felipe - Eagle Nest)	MNE Early Archaic (Viejo)	MNE Paleo-indian	Composite MNE Totals by Taxon
Pylodictis olivaris	2	31	6	2			41
Cypriformes		6	2				8
Catostomidae	3	7					10
Carpiodes carpio		9	2				11
Catostomus sp.		1					1
Cycleptus elongatus		9	1				10
Ictiobus niger	2	1	5				8
Ictiobus bubalus		3					3
Ictiobus sp.		13					13
Perciformes				2			2
Centrarchidae		1					2
Micropterus salmoides	1	2					3
Micropterus sp.		1					1
Morone chrysops		3					3
Aplodinotus grunniens		6	6				12
Rana catesbiana			1				1

Taxon	MNE Historic/Late Prehistoric (Historic - Infierno - Flecha)	MNE Terminal Late Archaic (Blue Hills - Flanders)	MNE Earlier Late Archaic (Cibola)	MNE Middle Archaic (San Felipe - Eagle Nest)	MNE Early Archaic (Viejo)	MNE Paleo-indian	Composite MNE Totals by Taxon
Rana pipiens		2					2
Chelonia		1					1
Testudinidae	1		1				2
Chelydra serpentina			1				1
Pseudemys sp.		1					1
Trionyx spiniferus	3	8	3	3			17
Pituophis sp.		1					1
Coluber constrictor or *Masticophis flagellum*		1					1
Crotalidae		1	1				2
Crotalus atrox			1				1
Crotalus sp.		1					1
Crotalus or *Agkistrodon* sp.		1					1
Agkistrodon contortrix	2	1					3
Aves		3					3
Aves (undetermined large bird			2				2

Taxon	**MNE Historic/Late Prehistoric (Historic - Infierno - Flecha)**	**MNE Terminal Late Archaic (Blue Hills - Flanders)**	**MNE Earlier Late Archaic (Cibola)**	**MNE Middle Archaic (San Felipe - Eagle Nest)**	**MNE Early Archaic (Viejo)**	**MNE Paleo-indian**	**Composite MNE Totals by Taxon**
species)							
Anatidae		1					1
Anatidae (size of *Aix sponsa)*		1					1
Anatidae (size of *Anas platyrhynchus*)		1					1
Aythya americana			1				1
Aythya sp.			1				1
cf. *Aythya* or *Melanitta* sp.			1				1
Anas platyrhynchus		1					1
Anas strepera				1			1
Anas cf. *discors* or *carolinensis*			1				1
Anas or *Branta* sp.			1				1
Branta canadensis		1					1
Chen sp.		1					1
Laridae			1				1
Geococcyx californicus			1				1

Taxon	**MNE Historic/Late Prehistoric (Historic - Infierno - Flecha)**	**MNE Terminal Late Archaic (Blue Hills - Flanders)**	**MNE Earlier Late Archaic (Cibola)**	**MNE Middle Archaic (San Felipe - Eagle Nest)**	**MNE Early Archaic (Viejo)**	**MNE Paleo-indian**	**Composite MNE Totals by Taxon**
Falconiformes		1					1
Accipitridae			1				1
Accipitridae (size similar to *Accipiter cooperi*)			1				1
Buteo cf. *jamaicensis*			1				1
Buteo cf. *lineatus*			1				1
Buteo cf. *lineatus* or *jamaicensis*		1					1
Buteo sp.		2	1				3
Falco cf. *sparverius*			1				1
Falco sp.		1					1
Ictinia cf. *mississippiensis*			1				1
Ictinia or *Falco* sp.			1				1
Colinus virginianus		13	7				20
cf. *Colinus virginianus* or *Callipepla squamata*		6	1				7
Meleagris gallapavo		1					1

Taxon	MNE Historic/Late Prehistoric (Historic - Infierno - Flecha)	MNE Terminal Late Archaic (Blue Hills - Flanders)	MNE Earlier Late Archaic (Cibola)	MNE Middle Archaic (San Felipe - Eagle Nest)	MNE Early Archaic (Viejo)	MNE Paleo-indian	Composite MNE Totals by Taxon
Zenaida asiatica		1					1
Mammalia (undetermined species)	1	6		3			10
Artiodactyla	2	4	1	4		2	13
Ariodactyla (large deer size)				1			1
Odocoileus cf. *hemionus*		3	1	6			10
Odocoileus virginianus	1	2	1				4
Odocoileus sp.	2	17	6	16	1		42
Antilocapra americana		3	3	2			8
cf. *Antilocapra americana*	1						1
Ovis sp.	1						1
Ovis or *Capra* sp.	2						2
Bison antiquus						7	7
Bison cf. *antiquus*						1	1
Bison bison		2					2
Bison or *Bos* sp.	1						1

Taxon	MNE Historic/Late Prehistoric (Historic - Infierno - Flecha)	MNE Terminal Late Archaic (Blue Hills - Flanders)	MNE Earlier Late Archaic (Cibola)	MNE Middle Archaic (San Felipe - Eagle Nest)	MNE Early Archaic (Viejo)	MNE Paleo-indian	Composite MNE Totals by Taxon
Equus sp. (large size)						1	1
Equus sp. (undetermined size)						2	2
Leporidae		10					10
Lepus californicus	5	61	15	3			84
Sylvilagus audubonii		1					1
Sylvilagus cf. *audubonii*		2	2	1			5
Sylvilagus cf. *floridanus*		2	1				3
Sylvilagus audubonii or *floridanus*	8	127	21	11		1	168
Rodentia		2		1			3
Castor canadensis	2	5	2	2			11
Ondatra zibethicus		7					7
Neotoma albigula	1	4		1			6
Neotoma cf. *albigula*	1		3				4
Neotoma cf. *floridana*			3				3
Neotoma micropus		2					2

Taxon	MNE Historic/Late Prehistoric (Historic - Infierno - Flecha)	MNE Terminal Late Archaic (Blue Hills - Flanders)	MNE Earlier Late Archaic (Cibola)	MNE Middle Archaic (San Felipe - Eagle Nest)	MNE Early Archaic (Viejo)	MNE Paleo-indian	Composite MNE Totals by Taxon
Neotoma sp.		7	1	1			9
Sigmodon hispidus	1	28	2				31
Geomys personatus		1					1
Pappogeomys castanops		1	1				2
Sciurus cf. *niger*			1				1
Spermophilus mexicanus		2					2
Spermophilus cf. *mexicanus*		1					1
Spermophilus variegatus		12	4				16
carnivore (undetermined species)		1					1
small carnivore (undetermined species)		1					1
large carnivore (undetermined species)		1					1
Canidae				1			1
small canid (undetermined species)		2		1			3
Canis familiaris		1					1

Taxon	MNE Historic/Late Prehistoric (Historic - Infierno - Flecha)	MNE Terminal Late Archaic (Blue Hills - Flanders)	MNE Earlier Late Archaic (Cibola)	MNE Middle Archaic (San Felipe - Eagle Nest)	MNE Early Archaic (Viejo)	MNE Paleo-indian	Composite MNE Totals by Taxon
Canis latrans		3					3
cf. *Canis latrans*			2				2
Canis cf. *familiaris* or *latrans*		6		2			8
Vulpes vulpes		1					1
Vulpes cf. *vulpes*		1					1
Vulpes velox		1	1				2
Vulpes cf. *velox*			1	1	1		3
Vulpes cf. *vulpes* or *velox*		1					1
Urocyon cinereoargenteus	3	9	2	1			15
large fox (undetermined species)		2	2				4
Lynx rufus			1				1
Spilogale sp.		4	1				5
large skunk (undetermined species)			1				1
Taxidea taxus		1					1
Bassariscus astutus	1	7	3				11

Taxon	MNE Historic/Late Prehistoric (Historic - Infierno - Flecha)	MNE Terminal Late Archaic (Blue Hills - Flanders)	MNE Earlier Late Archaic (Cibola)	MNE Middle Archaic (San Felipe - Eagle Nest)	MNE Early Archaic (Viejo)	MNE Paleo-indian	Composite MNE Totals by Taxon
Procyon lotor	2	7		2			11
Procyon cf. *lotor simus*		2					2
small mammal (undetermined species)			4	1			5
small – medium mammal (undetermined species)	1		1	1			3
medium mammal (undetermined species)	1		2	2			5
medium - large mammal (undetermined species)			1	1	1		3
large mammal (deer-sized, undetermined species)			1			3	3
large mammal (large deer-sized, undetermined species)						1	1
large mammal (small horse size, undetermined species)						1	1
large mammal (horse-bison size, undetermined species)						1	1

Taxon	MNE Historic/Late Prehistoric (Historic - Infierno - Flecha)	MNE Terminal Late Archaic (Blue Hills - Flanders)	MNE Earlier Late Archaic (Cibola)	MNE Middle Archaic (San Felipe - Eagle Nest)	MNE Early Archaic (Viejo)	MNE Paleo-indian	Composite MNE Totals by Taxon
large mammal (large horse-bison size, undetermined species)						1	1
large mammal (Bison-sized, undetermined species)						2	2
large mammal (undetermined species)	4	5	6	4	1	10	30
Totals =	**74**	**628**	**166**	**83**	**6**	**33**	**990**

Table 5.8: MNE % Values Aggregated by Regional Cultural Period

Taxon	**MNE % Historic/Late Prehistoric (Historic - Infierno - Flecha)**	**MNE % Terminal Late Archaic (Blue Hills - Flanders)**	**MNE % Earlier Late Archaic (Cibola)**	**MNE % Middle Archaic (San Felipe – Eagle Nest)**	**MNE % Early Archaic (Viejo)**	**MNE % Paleo-indian**	**Composite MNE % Totals by Taxon**
Osteichthyes	1.59	2.25	1.76		33.3		**2.04**
Scaphirhynchus platyrhynchus		0.16	0.59				**0.2**
Lepisosteus osseus		0.16					**0.1**
Lepisosteus cf. *spatula*		0.16					**0.1**
Lepisosteus sp.	6.35	2.4	2.94	2.3			**2.65**
Ictaluridae		1.12					**0.71**
Ictalurus furcatus	1.6	4.8	1.76	4.6			**3.87**
Ictalurus punctatus	1.6	1.29	2.35	2.3			**1.53**
Ictalurus punctatus or *mexicanus*		0.5					**0.3**
Ictalurus sp., subgenus *Ictulurus*		0.5	0.59				**0.4**
Ictalurus melas		0.16					**0.1**
Ictalurus natalis		0.16					**0.1**
Ictalurus sp.	6.35	4.7	1.76	3.5			**3.98**

Taxon	**MNE % Historic/Late Prehistoric (Historic - Infierno - Flecha)**	**MNE % Terminal Late Archaic (Blue Hills - Flanders)**	**MNE % Earlier Late Archaic (Cibola)**	**MNE % Middle Archaic (San Felipe – Eagle Nest)**	**MNE % Early Archaic (Viejo)**	**MNE % Paleo-indian**	**Composite MNE % Totals by Taxon**
Pylodictis olivaris	3.17	4.98	3.53	2.3			**4.18**
Cypriformes		0.96	1.18				**0.82**
Catostomidae	4.76	1.12					**1.02**
Carpiodes carpio		1.44	1.18				**1.12**
Catostomus sp.		0.16					**0.1**
Cycleptus elongatus		1.44	0.59				**1.02**
Ictiobus niger	3.17	0.16	2.94				**0.82**
Ictiobus bubalus		0.5					**0.3**
Ictiobus sp.		2.09					**1.33**
Perciformes				2.3			**0.2**
Centrarchidae		0.16					**0.2**
Micropterus salmoides	1.6	0.32					**0.3**
Micropterus sp.		0.16					**0.1**
Morone chrysops		0.5					**0.3**
Aplodinotus grunniens		0.96	3.53				**1.22**
Rana catesbiana			0.59				**0.1**

Taxon	MNE % Historic/Late Prehistoric (Historic - Infierno - Flecha)	MNE % Terminal Late Archaic (Blue Hills - Flanders)	MNE % Earlier Late Archaic (Cibola)	MNE % Middle Archaic (San Felipe – Eagle Nest)	MNE % Early Archaic (Viejo)	MNE % Paleo-indian	Composite MNE % Totals by Taxon
Rana pipiens		0.32					**0.2**
Chelonia		0.16					**0.1**
Testudinidae	1.6		0.59				**0.2**
Chelydra serpentina			0.59				**0.1**
Pseudemys sp.		0.16					**0.1**
Trionyx spiniferus	4.76	1.29	1.76	3.5			**1.7**
Pituophis sp.		0.16					**0.1**
Coluber constrictor or *Masticophis flagellum*		0.16					**0.1**
Crotalidae		0.16	0.59				**0.2**
Crotalus atrox			0.59				**0.1**
Crotalus sp.		0.16					**0.1**
Crotalus or *Agkistrodon* sp.		0.16					**0.1**
Agkistrodon contortrix	1.6	0.16					**0.3**
Aves		0.5					**0.3**
Aves (undetermined large bird			1.18				**0.2**

Taxon	**MNE % Historic/Late Prehistoric (Historic - Infierno - Flecha)**	**MNE % Terminal Late Archaic (Blue Hills - Flanders)**	**MNE % Earlier Late Archaic (Cibola)**	**MNE % Middle Archaic (San Felipe – Eagle Nest)**	**MNE % Early Archaic (Viejo)**	**MNE % Paleo-indian**	**Composite MNE % Totals by Taxon**
species)							
Anatidae		0.16					**0.1**
Anatidae (size of *Aix sponsa)*		0.16					**0.1**
Anatidae (size of *Anas platyrhynchus*)		0.16					**0.1**
Aythya americana			0.59				**0.1**
Aythya sp.			0.59				**0.1**
cf. *Aythya* or *Melanitta* sp.			0.59				**0.1**
Anas platyrhynchus		0.16					**0.1**
Anas strepera				1.16			**0.1**
Anas cf. *discors* or *carolinensis*			0.59				**0.1**
Anas or *Branta* sp.			0.59				**0.1**
Branta canadensis		0.16					**0.1**
Chen sp.		0.16					**0.1**
Laridae			0.59				**0.1**
Geococcyx californicus			0.59				**0.1**

Taxon	MNE % Historic/Late Prehistoric (Historic - Infierno - Flecha)	MNE % Terminal Late Archaic (Blue Hills - Flanders)	MNE % Earlier Late Archaic (Cibola)	MNE % Middle Archaic (San Felipe – Eagle Nest)	MNE % Early Archaic (Viejo)	MNE % Paleo-indian	Composite MNE % Totals by Taxon
Falconiformes		0.16					**0.1**
Accipitridae			0.59				**0.1**
Accipitridae (size similar to *Accipiter cooperi*)			0.59				**0.1**
Buteo cf. *jamaicensis*			0.59				**0.1**
Buteo cf. *lineatus*			0.59				**0.1**
Buteo cf. *lineatus* or *jamaicensis*		0.16					**0.1**
Buteo sp.		0.32	0.59				**0.3**
Falco cf. *sparverius*			0.59				**0.1**
Falco sp.		0.16					**0.1**
Ictinia cf. *mississippiensis*			0.59				**0.1**
Ictinia or *Falco* sp.			0.59				**0.1**
Colinus virginianus		2.09	4.12				**2.04**
cf. *Colinus virginianus* or *Callipepla squamata*		0.96	0.59				**0.71**
Meleagris gallapavo		0.16					**0.1**

Taxon	MNE % Historic/Late Prehistoric (Historic - Infierno - Flecha)	MNE % Terminal Late Archaic (Blue Hills - Flanders)	MNE % Earlier Late Archaic (Cibola)	MNE % Middle Archaic (San Felipe – Eagle Nest)	MNE % Early Archaic (Viejo)	MNE % Paleo-indian	Composite MNE % Totals by Taxon
Zenaida asiatica		0.16					**0.1**
Mammalia (undetermined species)	1.6	0.96		3.5			**1.02**
Artiodactyla	3.17	0.64	0.59	4.65		6.06	**1.33**
Ariodactyla (large deer size)				1.16			**0.1**
Odocoileus cf. *hemionus*		0.5	0.59	6.98			**1.02**
Odocoileus virginianus	1.6	0.32	0.59				**0.41**
Odocoileus sp.	3.17	5.1	3.5	18.6	16.7		**4.3**
Antilocapra americana		0.5	1.76	2.3			**0.82**
cf. *Antilocapra americana*	1.6						**0.1**
Ovis sp.	1.6						**0.1**
Ovis or *Capra* sp.	3.17						**0.2**
Bison antiquus						21.21	**0.7**
Bison cf. *antiquus*						3.03	**0.1**
Bison bison		0.32					**0.2**
Bison or *Bos* sp.	1.6						**0.1**

Taxon	MNE % Historic/Late Prehistoric (Historic - Infierno - Flecha)	MNE % Terminal Late Archaic (Blue Hills - Flanders)	MNE % Earlier Late Archaic (Cibola)	MNE % Middle Archaic (San Felipe – Eagle Nest)	MNE % Early Archaic (Viejo)	MNE % Paleo-indian	Composite MNE % Totals by Taxon
Equus sp. (large size)						3.03	**0.1**
Equus sp. (undetermined size)						6.06	**0.2**
Leporidae		1.6					**1.02**
Lepus californicus	7.9	9.8	8.8	3.5			**8.57**
Sylvilagus audubonii		0.16					**0.1**
Sylvilagus cf. *audubonii*		0.32	1.18	1.16			**0.5**
Sylvilagus cf. *floridanus*		0.32	0.59				**0.3**
Sylvilagus audubonii or *floridanus*	12.7	20.4	12.35	12.8		3.03	**17.14**
Rodentia		0.32		1.16			**0.3**
Castor canadensis	3.17	0.8	1.18	2.3			**1.1**
Ondatra zibethicus		1.12					**0.7**
Neotoma albigula	1.6	0.64		1.16			**0.6**
Neotoma cf. *albigula*	1.6		1.76				**0.4**
Neotoma cf. *floridana*			1.76				**0.3**
Neotoma micropus		0.32					**0.2**

Taxon	MNE % Historic/Late Prehistoric (Historic - Infierno - Flecha)	MNE % Terminal Late Archaic (Blue Hills - Flanders)	MNE % Earlier Late Archaic (Cibola)	MNE % Middle Archaic (San Felipe – Eagle Nest)	MNE % Early Archaic (Viejo)	MNE % Paleo-indian	Composite MNE % Totals by Taxon
Neotoma sp.		1.12	0.59	1.16			**0.92**
Sigmodon hispidus	1.6	4.5	1.18				**3.16**
Geomys personatus		0.16					**0.1**
Pappogeomys castanops		0.16	0.59				**0.2**
Sciurus cf. *niger*			0.59				**0.1**
Spermophilus mexicanus		0.32					**0.2**
Spermophilus cf. *mexicanus*		0.16					**0.1**
Spermophilus variegatus		1.93	2.35				**1.63**
carnivore (undetermined species)		0.16					**0.1**
small carnivore (undetermined species)		0.16					**0.1**
large carnivore (undetermined species)		0.16					**0.1**
Canidae				1.16			**0.1**
small canid (undetermined species)		0.32		1.16			**0.3**
Canis familiaris		0.16					**0.1**

Taxon	MNE % Historic/Late Prehistoric (Historic - Infierno - Flecha)	MNE % Terminal Late Archaic (Blue Hills - Flanders)	MNE % Earlier Late Archaic (Cibola)	MNE % Middle Archaic (San Felipe – Eagle Nest)	MNE % Early Archaic (Viejo)	MNE % Paleo-indian	Composite MNE % Totals by Taxon
Canis latrans		0.5					**0.3**
cf. *Canis latrans*			1.18				**0.2**
Canis cf. *familiaris* or *latrans*		0.96		2.3			**0.8**
Vulpes vulpes		0.16					**0.1**
Vulpes cf. *vulpes*		0.16					**0.1**
Vulpes velox		0.16	0.59				**0.2**
Vulpes cf. *velox*			0.59	1.16	16.7		**0.3**
Vulpes cf. *vulpes* or *velox*		0.16					**0.1**
Urocyon cinereoargenteus	4.76	1.44	1.18	1.16			**1.53**
large fox (undetermined species)		0.32	1.18				**0.4**
Lynx rufus			0.59				**0.1**
Spilogale sp.		0.64	0.59				**0.6**
large skunk (undetermined species)			0.59				**0.1**
Taxidea taxus		0.16					**0.1**
Bassariscus astutus	1.6	1.12	1.76				**1.12**

Taxon	MNE % Historic/Late Prehistoric (Historic - Infierno - Flecha)	MNE % Terminal Late Archaic (Blue Hills - Flanders)	MNE % Earlier Late Archaic (Cibola)	MNE % Middle Archaic (San Felipe – Eagle Nest)	MNE % Early Archaic (Viejo)	MNE % Paleo-indian	Composite MNE % Totals by Taxon
Procyon lotor	3.17	1.12		2.3			**1.12**
Procyon cf. *lotor simus*		0.32					**0.2**
small mammal (undetermined species)			2.35	1.16			**0.5**
small – medium mammal (undetermined species)	1.6		0.59	1.16			**0.3**
medium mammal (undetermined species)	1.6		1.18	2.3			**0.5**
medium - large mammal (undetermined species)			0.59	1.16	16.7		**0.3**
large mammal (deer-sized, undetermined species)			0.59			9.09	**0.3**
large mammal (large deer-sized, undetermined species)						3.03	**0.1**
large mammal (small horse size, undetermined species)						3.03	**0.1**
large mammal (horse-bison size, undetermined species)						3.03	**0.1**
large mammal (large horse-bison size, undetermined						3.03	**0.1**

Taxon	**MNE % Historic/Late Prehistoric (Historic - Infierno - Flecha)**	**MNE % Terminal Late Archaic (Blue Hills - Flanders)**	**MNE % Earlier Late Archaic (Cibola)**	**MNE % Middle Archaic (San Felipe – Eagle Nest)**	**MNE % Early Archaic (Viejo)**	**MNE % Paleo-indian**	**Composite MNE % Totals by Taxon**
species)							
large mammal (bison-sized, undetermined species)						6.06	**0.2**
large mammal (undetermined species)	6.35	0.8	3.53	4.65	16.7	30.3	**3.06**
Totals ≈	**100**	**100**	**100**	**100**	**100**	**100**	**100**

Table 5.9: Composite NISP, MNE, and MNI Data Arranged by Cultural Stage

Nominal Cultural Stage and Associated Period	NISP	MNE	MNI
Historic – Late Prehistoric (Flecha-Infierno-Historic)	162	73	73
Terminal Late Archaic (Blue Hills-Flanders)	3786	628	628
Late Archaic (Cibola)	530	166	166
Middle Archaic (Eagle Nest-San Felipe)	205	83	83
Early Archaic (Viejo)	13	3	3
Paleoindian (Aurora-Bonfire-Oriente)	205	33	33

Table 5.10: NISP Comparison by Vertebrate Class, Body Size, and Cultural Period

Body Size	NISP Historic – Late Prehistoric	NISP Terminal Late Archaic	NISP Late Archaic	NISP Middle Archaic	NISP Early Archaic	NISP Paleo-indian
Fish (undetermined taxa)	2	230	19	0	5	0
Fish (small)	1	41	4	0	0	0
Fish (small - medium)	24	208	37	2	0	0
Fish (medium)	14	385	41	7	0	0
Fish (medium - large)	7	126	23	8	0	0

Body Size	NISP Historic – Late Prehistoric	NISP Terminal Late Archaic	NISP Late Archaic	NISP Middle Archaic	NISP Early Archaic	NISP Paleo-indian
Fish (large)	2	59	7	5	0	0
Amphibian	0	3	2	0	0	0
Reptile (turtle)	5	34	10	4	0	0
Reptile (snake)	1	7	2	0	0	0
Bird (small – medium)	0	37	17	0	0	0
Bird (large)	0	16	12	2	0	0
Mammal (undetermined)	1	623	0	5	0	0
Mammal (small)	5	110	52	4	0	0
Mammal (medium, rabbit)	40	1501	211	33	0	1
Mammal (medium, rodent)	2	6	2	3	0	0
Mammal (medium, carnivore)	6	85	17	17	1	0
Mammal (medium, undetermined)	3	0	15	7	3	0
Mammal (large)	48	217	57	108	4	202

Table 5.11: MNE/MNI Comparison by Vertebrate Class, Body Size, and Cultural Period

Body Size	**MNE/MNI Historic – Late Prehistoric**	**MNE/ MNI Terminal Late Archaic**	**MNE/ MNI Late Archaic**	**MNE/ MNI Middle Archaic**	**MNE/ MNI Early Archaic**	**MNE/MNI Paleoindian**
Fish (undetermined taxa)	1	5	4	0	1	0
Fish (small)	1	20	3	0	0	0
Fish (small - medium)	12	39	10	2	0	0
Fish (medium)	14	126	35	6	0	0
Fish (medium - large)	4	35	6	8	0	0
Fish (large)	2	30	7	5	0	0
Amphibian	0	2	1	0	0	0
Reptile (turtle)	4	10	5	3	0	0
Reptile (snake)	1	6	2	0	0	0
Bird (small – medium)	0	21	11	0	0	0
Bird (large)	0	11	11	2	0	0
Mammal (undetermined)	1	6	0	3	0	0
Mammal (small)	3	67	16	3	0	0

Body Size	**MNE/MNI Historic – Late Prehistoric**	**MNE/ MNI Terminal Late Archaic**	**MNE/ MNI Late Archaic**	**MNE/ MNI Middle Archaic**	**MNE/ MNI Early Archaic**	**MNE/MNI Paleoindian**
Mammal (medium, rabbit)	13	203	39	14	0	1
Mammal (medium, rodent)	2	5	2	2	0	0
Mammal (medium, carnivore)	6	51	16	7	1	0
Mammal (medium, undetermined)	2	0	4	4	1	0
Mammal (large)	22	36	16	30	2	32

Table 5.12: Relationship between Observed Growth Annuli and Body Size

Species	**Observed Growth Annuli**	**Recorded Body Size**
Ictiobus niger	5	Small
Carpiodes carpio	6	Small – Medium
Ictalurus sp.	7	Small – Medium
Pylodictis olivaris	8	Medium
Ictiobus niger	9	Medium
Ictiobus niger	11	?

Species	**Observed Growth Annuli**	**Recorded Body Size**
Ictiobus sp.	11	Medium
Ictalurus sp.	11 – 12	Large
Ictiobus niger	12 – 15	Large
Pylodictis olivaris	14	Large
Pylodictis olivaris	19	Large
Pylodictis olivaris	20	Medium – Large
Pylodictis olivaris	20+	Very Large
Ictalurus sp.	21+	Large
Pylodictis olivaris	25	Medium - Large

Appendix 3

Table 6.1: Manufacturing Residue Characteristics Evident Microscopically (after Lemoine 1997:Table 4.2)

Raw Material Modified in Manufacturing Process	Material Used to Modify Raw Material	Resulting Surface Striations	Resulting Surface Cracks
bone (wet and dry differ by degree)	chert	prominent, variable in width and depth, parallel	small, short, few (fewer on dry bone)
antler (dry)	chert	prominent, variable in width and depth	short, few
antler (wet)	chert	many, prominent	tearing predominant
antler (wet)	bone	--	extensive tearing
bone	coarse grindstone	many, smooth surface	--
bone	fine grindstone	many, smoothed high points, but less smooth surface	--
bone	grit on string saw, thin stone slab, or thin bone	sawn area appears ground w/many striations, smooth surface, but very little polish (string saws leave curved cuts)	--

Table 6.2: Use Wear Residue Characteristics Adapted from Lemoine (1997) for Current Study of Lower Pecos Bone Technology

Tool Use Material	Striations	Polish	Other
wood	smooth and continuous, large	non-invasive	osteons visible

Tool Use Material	Striations	Polish	Other
wet hide	rare, small, smooth (made by inclusions)	invasive	--
dry hide	small, smooth	invasive	--
hide and hair	fine, coarse, may seem like an abrasive polish	--	--
fish scales	variable size and direction	--	--
wet antler	wide, shallow, coarse	--	--
dry antler	similar to wood	non-invasive	--
meat	none	light, invasive, may appear non-invasive	osteons visible
sinew	smooth, sharp	non-invasive	--

Table 6.3: Definition of Observed Bead Forms from Arenosa Shelter

Defined Form	Description
bead, antler	Tapered tubular bead fashioned from blank grooved and snapped from short segment of deer antler tine, hollowed, scraped laterally in basal and medial sections, with tip ground to final slightly rounded form.
bone bead, faceted	Very short (<10 mm length), narrow (< 10 mm width), tubular bead fashioned from blank produced from thin-walled mammalian long bone by groove and snap method, with additional surface modification and with final shaping or finishing by grinding and polishing producing multiple facets on surface and ends.
bone bead, incised Form 1	Short to medium (<30 mm length), narrow (< 10 mm width), tubular bead fashioned from blank produced from thin-walled mammalian long bone by groove and snap method, with additional surface modification to produce decoration by incising of multiple transverse grooves along length of bead at 1 – 2 mm intervals.

Defined Form	Description
bone bead, incised Form 2	Short (<20 mm length), medium (10 - 20 mm width), tubular bead fashioned from blank produced from thick-walled mammalian long bone by groove and snap method, with additional surface modification to produce decoration by incising of multiple transverse grooves along length of bead at 1 – 2 mm intervals.
bone bead, undecorated, Form 1	Highly polished, tapered, tubular bead fashioned from blank produced from artiodactyl phalange by groove and snap method, scraped laterally, then ground and/or polished to final slightly rounded form.
bone bead, undecorated, Form 2	Short (<20 mm length), narrow (< 10 mm width), tubular bead fashioned from blank produced from thin-walled avian long bone by groove and snap method, with minimal additional surface modification.
bone bead, undecorated, Form 3	Short (<20 mm length), narrow (< 10 mm width), tubular bead fashioned from blank produced from thin-walled avian long bone by groove and snap method, with additional surface modification by scraping to remove periosteum and/or to shape surface.
bone bead, undecorated, Form 4	Short (<20 mm length), medium (10 - 20 mm width), tubular bead fashioned from blank produced from thin-walled avian long bone by groove and snap method, with minimal additional surface modification.
bone bead, undecorated, Form 5	Short (<20 mm length), medium (10 - 20 mm width), tubular bead fashioned from blank produced from thin-walled avian long bone by groove and snap method, with additional surface modification by scraping to remove periosteum and/or to shape surface.
bone bead, undecorated, Form 6	Short (<20 mm length), medium (10 - 20 mm width), tubular bead fashioned from blank produced from thin-walled avian long bone by groove and snap method, with additional surface modification by scraping to remove periosteum and/or to shape surface, with final shaping or finishing by grinding and polishing producing smooth rounded surface and ends.
bone bead, undecorated, Form 7	Medium (20 - 30 mm length), narrow (< 10 mm width), tubular bead fashioned from blank produced from thin-walled avian long bone by groove and snap method, with minimal additional surface modification.
bone bead, undecorated, Form 8	Medium (20 - 30 mm length), narrow (< 10 mm width), tubular bead fashioned from blank produced from thin-walled avian long bone by groove and snap method, with additional surface modification by scraping to remove periosteum and/or to shape surface.
bone bead, undecorated, Form 9	Medium (20 - 30 mm length), narrow (< 10 mm width), tubular bead fashioned from blank produced from thin-walled avian long bone by groove and snap method, with additional surface modification by scraping to remove periosteum and/or to shape surface, with final shaping or finishing by grinding and polishing producing smooth rounded surface and ends.

Defined Form	Description
bone bead, undecorated, Form 10	Medium (20 - 30 mm length), medium (10 - 20 mm width), tubular bead fashioned from blank produced from thin-walled avian long bone by groove and snap method, with minimal additional surface modification.
bone bead, undecorated, Form 11	Medium (20 - 30 mm length), medium (10 - 20 mm width), tubular bead fashioned from blank produced from thin-walled avian long bone by groove and snap method, with additional surface modification by scraping to remove periosteum and/or to shape surface, with final shaping or finishing by grinding and polishing producing smooth rounded surface and ends.
bone bead, undecorated, Form 12	Medium (20 - 30 mm length), medium (10 - 20 mm width), tubular bead fashioned from blank produced from medium thick-walled avian long bone by groove and snap method, with minimal additional surface modification.
bone bead, undecorated, Form 13	Long (>30 mm length), narrow (< 15 mm width), tubular bead fashioned from blank produced from thin-walled avian long bone by groove and snap method, with additional surface modification by scraping to remove periosteum and/or to shape surface, with final shaping or finishing by grinding and polishing producing smooth rounded surface and ends.
bone bead, undecorated, Form 14	Short (<20 mm length), narrow (< 10 mm width), tubular bead fashioned from blank produced from thin-walled mammalian long bone by groove and snap method, with minimal additional surface modification.
bone bead, undecorated, Form 15	Short (<20 mm length), narrow (< 10 mm width), tubular bead fashioned from blank produced from thin-walled mammalian long bone by groove and snap method, with additional surface modification by scraping to remove periosteum and/or to shape surface.
bone bead, undecorated, Form 16	Short (<20 mm length), narrow (< 10 mm width), tubular bead fashioned from blank produced from thin-walled mammalian long bone by groove and snap method, with additional surface modification by scraping to remove periosteum and/or to shape surface, with final shaping or finishing by grinding and polishing producing smooth rounded surface and ends.
bone bead, undecorated, Form 17	Short (<20 mm length), narrow (< 10 mm width), tubular bead fashioned from blank produced from medium thick-walled mammalian long bone by groove and snap method, with additional surface modification by scraping to remove periosteum and/or to shape surface, with final shaping or finishing by grinding and polishing producing smooth rounded surface and ends.
bone bead, undecorated, Form 18	Short (<20 mm length), narrow (< 10 mm width), tubular bead fashioned from blank produced from thick-walled mammalian long bone by groove and snap method, with additional surface modification by scraping to remove periosteum and/or to shape surface, with final shaping or finishing by grinding and polishing producing smooth rounded surface and ends.

Defined Form	Description
bone bead, undecorated, Form 19	Short (<20 mm length), medium (10 - 20 mm width), tubular bead fashioned from blank produced from thin-walled mammalian long bone by groove and snap method, with minimal additional surface modification.
bone bead, undecorated, Form 20	Short (<20 mm length), medium (10 - 20 mm width), tubular bead fashioned from blank produced from thin-walled mammalian long bone by groove and snap method, with additional surface modification by scraping to remove periosteum and/or to shape surface.
bone bead, undecorated, Form 21	Short (<20 mm length), medium (10 - 20 mm width), tubular bead fashioned from blank produced from medium thick-walled mammalian long bone by groove and snap method, with additional surface modification by scraping to remove periosteum and/or to shape surface.
bone bead, undecorated, Form 22	Short (<20 mm length), medium (10 - 20 mm width), tubular bead fashioned from blank produced from medium thick-walled mammalian long bone by groove and snap method, with additional surface modification by scraping to remove periosteum and/or to shape surface, with final shaping or finishing by grinding and polishing producing smooth rounded surface and ends.
bone bead, undecorated, Form 23	Short (<20 mm length), medium (10 - 20 mm width), tubular bead fashioned from blank produced from thick-walled mammalian long bone by groove and snap method, with minimal additional surface modification.
bone bead, undecorated, Form 24	Medium (20 - 30 mm length), narrow (< 10 mm width), tubular bead fashioned from blank produced from thin-walled mammalian long bone by groove and snap method, with minimal additional surface modification.
bone bead, undecorated, Form 25	Medium (20 - 30 mm length), narrow (< 10 mm width), tubular bead fashioned from blank produced from thin-walled mammalian long bone by groove and snap method, with additional surface modification by scraping to remove periosteum and/or to shape surface.
bone bead, undecorated, Form 26	Medium (20 - 30 mm length), narrow (< 10 mm width), tubular bead fashioned from blank produced from thin-walled mammalian long bone by groove and snap method, with additional surface modification by scraping to remove periosteum and/or to shape surface, with final shaping or finishing by grinding and polishing producing smooth rounded surface and ends.

Defined Form	Description
bone bead, undecorated, Form 27	Medium (20 - 30 mm length), narrow (< 10 mm width), tubular bead fashioned from blank produced from medium thick-walled mammalian long bone by groove and snap method, with additional surface modification by scraping to remove periosteum and/or to shape surface, with final shaping or finishing by grinding and polishing producing smooth rounded surface and ends.
bone bead, undecorated, Form 28	Medium (20 - 30 mm length), narrow (< 10 mm width), tubular bead fashioned from blank produced from thick-walled mammalian long bone by groove and snap method, with additional surface modification by scraping to remove periosteum and/or to shape surface, with final shaping or finishing by grinding and polishing producing smooth rounded surface and ends.
bone bead, undecorated, Form 29	Medium (20 - 30 mm length), medium (10 - 20 mm width), tubular bead fashioned from blank produced from medium thick-walled mammalian long bone by groove and snap method, with additional surface modification by scraping to remove periosteum and/or to shape surface.
bone bead, undecorated, Form 30	Medium (20 - 30 mm length), medium (10 - 20 mm width), tubular bead fashioned from blank produced from medium thick-walled mammalian long bone by groove and snap method, with additional surface modification by scraping to remove periosteum and/or to shape surface, with final shaping or finishing by grinding and polishing producing smooth rounded surface and ends.
bone bead, undecorated, Form 31	Medium (20 - 30 mm length), medium (10 - 20 mm width), tubular bead fashioned from blank produced from thick-walled mammalian long bone by groove and snap method, with minimal additional surface modification.
bone bead, undecorated, Form 32	Long (>30 mm length), narrow (< 10 mm width), tubular bead fashioned from blank produced from thin-walled mammalian long bone by groove and snap method, with minimal additional surface modification.
bone bead, undecorated, Form 33	Long (>30 mm length), medium (10 - 20 mm width), tubular bead fashioned from blank produced from medium thick-walled mammalian long bone by groove and snap method, with additional surface modification by scraping to remove periosteum and/or to shape surface.
bone bead, undecorated, Form 34	Long (>30 mm length), medium (10 - 20 mm width), tubular bead fashioned from blank produced from medium thick-walled mammalian long bone by groove and snap method, with additional surface modification by scraping to remove periosteum and/or to shape surface, with final shaping or finishing by grinding and polishing producing smooth rounded surface and ends.

Defined Form	Description
bone bead, undecorated, Form 35	Long (>30 mm length), medium (10 - 20 mm width), tubular bead fashioned from blank produced from thick-walled mammalian long bone by groove and snap method, with minimal additional surface modification.
bone bead, undecorated, Form 36	Long (>30 mm length), medium (10 - 20 mm width), tubular bead fashioned from blank produced from thick-walled mammalian long bone by groove and snap method, with additional surface modification by scraping to remove periosteum and/or to shape surface, with final shaping or finishing by grinding and polishing producing smooth rounded surface and ends.

Table 6.4: Definition of Implement Forms at Arenosa Shelter

Defined Form	Description
billet, soft hammer flaker, antler	Long tubular tool fashioned from segment of deer antler basal beam, with polished, broadly rounded ends and battering or deep cutmarks adjacent to ends.
chisel, antler	Short tapered tool fashioned from segment of deer antler tine with end beveled by grinding and/or scraping, polished by use.
pressure flaking tool, antler tine	Short tapered tool fashioned from segment of deer antler tine with tapered to broadly rounded tip profile that exhibits pitting of tip and oblique to longitudinal scrapes and striations emanating from tip.
awl/bodkin	Medium length tapering tool (<100 mm) with u-shaped medial cross section and tapered oval cross section distally. Tool fashioned from blank derived from distal segment of artiodactyl metacarpal diaphysis, its anterior surface longitudinally removed by chopping or grooving/snapping. Medial section scraped and/or ground to round or smooth edges. Tip section modified distally by grinding and/or scraping to tapered oval cross section and variable in terminal profile and width; it may exhibit sharp expansion or rounding. Proximal section of tool may retain distal articulation of metacarpal and may exhibit modification of distal condyles by grinding through to underlying cancellous bone.
bodkin	Short to medium length (<100 mm) tapering tool with u-shaped medial cross section and tapered oval cross section distally. Tool fashioned from blank derived from distal segment of artiodactyl metacarpal diaphysis, its anterior surface longitudinally removed by chopping or grooving/snapping. Medial section scraped and/or ground to round or smooth edges. Tip section modified distally by grinding and/or scraping to tapered oval cross section and variable in terminal profile and width; it may exhibit sharp expansion or rounding. Proximal section of tool may retain distal articulation of metacarpal and may exhibit modification of distal condyles by grinding through to underlying cancellous bone.

Defined Form	Description
awl/perforator	Medium to long (60 – 130 mm) narrow (≤ 10 mm) tool with tapered very constricted tip section with approximately circular cross section. Tool fashioned from long bone of medium size mammal or from blank removed from artiodactyl long bone by grooving/snapping. Tool shaped by scraping and/or grinding.
bodkin/perforator	Medium length tapering tool (<100 mm) with u-shaped medial cross section and tapered oval cross section distally. Tool fashioned from blank derived from distal segment of artiodactyl metacarpal diaphysis, its anterior surface longitudinally removed by chopping or grooving/snapping. Medial section scraped and/or ground to round or smooth edges. Tip section long, narrow, and sharply tapered, modified distally by grinding and/or scraping to tapered oval cross section. Proximal section of tool may retain distal articulation of metacarpal and may exhibit modification of distal condyles by grinding through to underlying cancellous bone.
expedient tool, butchering, utilized fish scale	Short to medium length (<50 mm) tool fashioned from large gar scale, with edges modified by wear from utilization to exhibit medium to bright non-invasive polish on high points and visible osteons.
expedient tool, butchering	Medium (50 – 60 mm) tool fashioned from helically fractured artiodactyl long bone fragment, with lateral edge modified by unifacial or bifacial hard hammer percussion flaking to produce cutting edge. Flake scars exhibit bright, invasive polish and slight rounding on high points.
expedient tool, cutting	Medium (50 – 60 mm) tool fashioned from utilized artiodactyl humerus grooved/snapped tool manufacturing debitage, with distal lateral edge modified by unifacial hard hammer percussion flaking to produce cutting edge. Flake scars exhibit medium, invasive polish and slight rounding on high points.
expedient tool, hide-working	Long (>100 mm) narrow (≤ 10 mm) tool fashioned from partially finished artiodactyl tool blank, with lateral edges and distal end modified by hard hammer percussion flaking to produce scalloped edge. Flake scars exhibit weak, non-invasive polish and slight rounding on high points.
expedient tool, spatulate, bone	Long (>100 mm) medium (20 – 30 mm) width tool fashioned from helically fractured ulna diaphysis of medium-sized carnivore, scraped longitudinally. Ventral edge and distal fracture with rounding and polish associated with hide/hair.
preform, fish hook	Short (<20 mm) narrow (≤ 10 mm) tool with deep distal bifurcation cut or scraped approximately half the length of the tool and removed from blank by grooving/snapping. Bifurcation leaves tips approximately 3 mm wide with oval cross section shaped by grinding.
needle	Medium (50 – 100 mm) narrow (≤ 10 mm) tool fashioned from blank grooved/snapped from medium or large mammal long bone, then scraped and ground to shape. Proximal end may have multiple transverse grooves, some prominent. Surface exhibits medium non-invasive polish with osteons visible.

Defined Form	Description
perforator	Medium to long (60 – 130 mm) relatively narrow (≤ 15 mm) tool with long, tapered, very constricted tip section with approximately circular cross section. Terminal profile of tip is slightly rounded to slightly beveled. Tool fashioned from long bone of medium size mammal, from blank removed from artiodactyl long bone by grooving/snapping, or from refitting of broken tools. Tool shaped by scraping and/or grinding.
perforator, catfish spine	Medium (50 – 100 mm) narrow (≤ 10 mm) tool fashioned from catfish pectoral spine distal tip modified to approximately circular cross section. Tip has bright, non-invasive polish on high points.
pressure flaking tool, bone	Short to medium length (<100 mm) narrow (≤ 10 mm) tapering tool with long, tapered, very constricted tip section with approximately circular cross section and rounded or slightly beveled tip profile. The tip section has prominent coarse oblique to longitudinal lateral scrapes and striations. It may also exhibit small areas of crushing or tear-out.
rib tool	Short to medium length (<100 mm) narrow (≤ 10 mm) tool fashioned from blank grooved/snapped from large mammal rib, with further modification by scraping. Bright non-invasive and rounding present on high points.
spatulate	Medium to long (60 – 160 mm), narrow to wide (≤25 mm) tapering tool with u-shaped medial cross section and tapered oval cross section distally. Tool fashioned from blank grooved/snapped from proximal or distal segment of artiodactyl metapodial diaphysis and may retain epiphysis identifiable as metatarsal proximal articulation. Medial section scraped and/or ground to round or smooth edges. Tip section long, narrow, and tapered, modified distally by grinding and/or scraping to tapered oval cross section. Tip characteristics variable, from moderately wide, with sharp or gradual taper. Tips may be rounded to very narrow and sharp. Dorso-ventral beveling may be present at tip. Lateral edges may have multiple transverse grooves of variable width and depth with associated striations.
spatulate/bodkin	Short to medium length (<100 mm) tapering tool with u-shaped medial cross section and tapered oval cross section distally. Tool fashioned from blank derived from distal segment of artiodactyl metacarpal diaphysis, its anterior surface longitudinally removed by chopping or grooving/snapping. Proximal section may be scraped to shape or remove periosteum and intercondylar groove may be widened mechanically. Medial section scraped and/or ground internally and externally to round or smooth edges. Tip section modified distally by grinding and/or scraping to tapered oval cross section and variable in terminal profile and width; it may exhibit sharp expansion or rounding. Proximal section of tool may retain distal articulation of metacarpal and may exhibit modification of distal condyles by grinding through to underlying cancellous bone.
spatulate, catfish spine	Medium (50 – 100 mm) narrow (≤ 10 mm) tool fashioned from catfish pectoral spine distal tip scraped and/or ground to oval cross section. Diaphysis of spine may be scraped and/or ground to shape. Tool has bright, non-invasive polish on high points.
spatulate, creaser	Short to medium length (<100 mm) tapering tool with u-shaped medial cross section and tapered oval cross section distally.

Defined Form	Description
	Tool fashioned from blank derived from distal segment of artiodactyl metacarpal diaphysis, its anterior surface longitudinally removed by chopping or grooving/snapping. Proximal section may be scraped to shape or remove periosteum and intercondylar groove may be widened mechanically. Medial section scraped and/or ground internally and externally to round or smooth edges. Tip section modified distally by grinding and/or scraping to tapered, gently rounded, beveled dorso-ventrally to narrow oval cross section. Proximal section of tool may retain distal articulation of metacarpal and may exhibit modification of distal condyles by grinding through to underlying cancellous bone.
spatulate, distally notched	Medium (50 – 100 mm) relatively narrow (< 16 mm) tool with shallow to deep (2.5 – 8 mm) distal bifurcation cut or scraped into distal end of tool. Tool may be manufactured from blank removed from artiodactyl long bone by grooving/snapping or on helically fractured long bone fragment. Bifurcation leaves tips approximately 2- 5 mm wide with oval cross section shaped by grinding. Use wear produces bright non-invasive polish and limited rounding on high points.
spatulate, incised	Medium to long (60 – 160 mm), narrow to wide (≤25 mm) tapering tool with u-shaped medial cross section and tapered oval cross section distally. Tool fashioned from blank grooved/snapped from proximal or distal segment of artiodactyl metapodial diaphysis and may retain epiphysis identifiable as metatarsal proximal articulation. Medial section scraped and/or ground to round or smooth edges. Tip section long, narrow, and tapered, modified distally by grinding and/or scraping to tapered oval cross section. Tip characteristics variable, from moderately wide, with sharp or gradual taper. Tips may be rounded to very narrow and sharp. Dorso-ventral beveling may be present at tip. Lateral edges may have multiple transverse grooves of variable width and depth with associated striations. Tool has multiple incised transverse or oblique parallel lines, chevrons, and/or cross-hatching on ventral surface lateral edges and across end proximally. Proximal end may also have drilled holes.
spatulate, narrow	Medium to long (60 – 160 mm), relatively narrow (< 16 mm) tapering tool with triangular to tapered oval cross section distally. Tool fashioned from blank grooved/snapped from proximal artiodactyl metapodial diaphysis. Medial section scraped and/or ground to round or smooth edges. Tip section long, narrow, and tapered, modified distally by grinding and/or scraping to tapered oval cross section. Tip characteristics variable, from moderately wide, with sharp or gradual taper. Tips may be rounded to very narrow and sharp. Dorso-ventral beveling may be present at tip. Lateral edges may have multiple transverse grooves of variable width and depth with associated striations. Tool has multiple incised transverse or oblique parallel lines, chevrons, and/or cross-hatching on ventral surface lateral edges and across end proximally. Proximal end may also have drilled holes.
spatulate, ulna	Medium to long (60 – 125 mm), relatively narrow (< 16 mm) tapering tool with triangular to tapered oval cross section distally. Tool fashioned from proximal artiodactyl ulna diaphysis that retains articulation. Medial section scraped. Tip section long, narrow, and tapered, modified distally by grinding and/or scraping to tapered oval cross section. Lateral edges of proximal end may have multiple transverse grooves of variable width and depth associated with possible hafting modification.

Defined Form	Description
wedge	Short (<35 mm) relatively narrow to wide (<25 mm) sharply tapering tool with multiple transverse grooves extending across faces, with slight tip tear-out.
woodworking tool, beveled and faceted	Medium to long (60 – 160 mm), narrow to wide (≤25 mm) tool with u-shaped cross section. Tool fashioned from debitage remaining when blank grooved/snapped from proximal or distal segment of artiodactyl metapodial diaphysis. Exterior surface of tool scraped to remove periosteum and/or to shape tool. Tip section modified distally by grinding to produce distal dorso-ventral bevel with multiple facets.

Table 6.5: Diachronic Comparison of Frequency Data for Mammal Bone-Derived Ornaments in Arenosa Shelter Bone Artifact Sample

Cultural Period	Cottontail	Jackrabbit	Medium Carnivore	Artiodactyl	Indeterminate Mammal
Historic - Late Prehistoric	2	4	1	0	0
Terminal Late Archaic	8	29	43	12	6
Late Archaic	14	20	8	0	2
Middle Archaic	0	2	5	2	2
No Provenience	2	4	1	0	0

Table 6.6: Diachronic Comparison of Frequency Data for Mammal Bone-Derived Implements in Arenosa Shelter Bone Artifact Sample

Cultural Period	Cottontail	Jackrabbit	Medium Carnivore	Artiodactyl	Indeterminate Mammal
Historic - Late Prehistoric	0	0	0	17	3
Terminal Late Archaic	0	0	2	168	2
Late Archaic	0	0	0	31	2
Middle Archaic	0	0	0	49	2
No Provenience	0	0	0	13	1

Table 6.7: Frequency and Context Data for Arenosa Shelter Bead, Bone Tube, and Manufacturing Byproducts

Form	#	Cultural Context	Taxon	Element	Length (mm)	Width (mm)	Thick-ness (mm)	Comments
antler bead	1	Late Archaic	*Odocoileus* sp.	antler tine	26	13	10	Medium-length, medium-width tapered bead with oval cross-section and cancellous bone on interior. Has medium invasive polish and rounding of high points typical of wear from dry hide.
antler tube fragment	1	Middle Archaic	*Odocoileus* sp.	antler tine	48	13	10	Long, medium-width tapered tine section with oval cross-section. Longitudinally scraped, with distal grinding with no obvious use wear.

Form	#	Cultural Context	Taxon	Element	Length (mm)	Width (mm)	Thick-ness (mm)	Comments
bone bead, faceted	1	Late Archaic	*Lepus californicus*	radius diaphysis	8	8	7	Short, oval shaped bead with 10 indistinct ground facets and bright non-invasive polish on high points from silica-rich plants.
bone bead fragment, faceted	1	Terminal Late Archaic	*Buteo* sp.	ulna diaphysis	16.5	7	6.5	Short tubular bead split longitudinally with several ground facets along its length. Has medium invasive polish and slight rounding of high points typical of wear from dry hide.
bone bead fragment, incised, Form 1	1	Historic – Late Prehistoric	*Buteo* sp.	radius diaphysis	32	7	4	Long, narrow bead with 13 annular grooves incised at 2 mm intervals. Bright invasive polish with internal and external rounding of ends and visible micro-pitting typical of wear from dry hide.
bone bead fragment, incised, Form 1	1	Historic – Late Prehistoric	*Lepus californicus*	tibia diaphysis	11	8	6.5	Short, narrow bead with 1 annular groove incised at midpoint. Bright, invasive polish present with end rounding and common micro-pitting typical of wear from dry hide.
bone bead fragment, incised, Form 1	1	Historic – Late Prehistoric	*Lepus californicus*	phalange	22	4	3	Medium, narrow tubular bead with 13 annular grooves incised, with slightly invasive polish and micro-pitting typical of wear from dry hide, with visible osteons.

Form	#	Cultural Context	Taxon	Element	Length (mm)	Width (mm)	Thick-ness (mm)	Comments
bone bead, incised, Form 1	1	Historic – Late Prehistoric	*Lepus californicus*	phalange	18.5	5	4	Short length narrow bead with 7 annular grooves incised at 1 mm intervals, with terminal fracture at one groove. Medium, slightly invasive polish present with common pitting typical of wear from dry hide.
bone bead, incised, Form 1	1	Historic – Late Prehistoric	*Sylvilagus* sp.	tibia, distal diaphysis	21	4	3	Medium, narrow tubular bead with 6 annular grooves incised at 2 mm intervals, with bright slightly invasive polish and rounding of high points from hide with hair.
bone bead, incised, Form 1	1	Terminal Late Archaic	*Sylvilagus* sp.	phalange	17	4	3.5	Short length narrow bead with 11 annular grooves incised at 1 mm intervals. Bright invasive polish with internal and external rounding of ends and visible micro-pitting typical of wear from dry hide.
bone bead, incised, Form 2	1	Terminal Late Archaic	Carnivora	radius diaphysis	13	11	9.5	Short, medium-width bead with single annular groove incised at mid-point. No apparent wear, but was ground and polished during manufacturing.

Form	#	Cultural Context	Taxon	Element	Length (mm)	Width (mm)	Thick-ness (mm)	Comments
bone bead, incised, Form 2	1	Terminal Late Archaic	Carnivora	radius diaphysis	16	10	8	Short, medium-width bead from large fox-sized carnivore, with 10 – 15 partial annular grooves along its length. Bright invasive polish with internal and external rounding of ends and visible micro-pitting typical of wear from dry hide.
bone bead, undecorated, Form 1	1	Terminal Late Archaic	Artiodactyla	phalange diaphysis	13	12	10.5	Short, medium-width tapered bead with oval cross-section, but lacks cancellous bone on interior. Scraped, then polished during manufacturing process. Has bright invasive polish with internal and external rounding of ends typical of wear from dry hide.
bone bead, undecorated, Form 1	1	Terminal Late Archaic	Artiodactyla	phalange diaphysis	25	15	12	Medium length, medium-width tapered bead with oval cross-section, but lacks cancellous bone on interior. Scraped, then distally ground during manufacturing process. No apparent wear.
bone bead fragment, undecorated, Form 2	1	Terminal Late Archaic	Aves	radius diaphysis	11.5	8.5	4	Short tubular bead from hawk-sized bird. Minimal modification with grinding to smooth ends. Medium polish from hide with hair.

Form	#	Cultural Context	Taxon	Element	Length (mm)	Width (mm)	Thick-ness (mm)	Comments
bone bead fragment, undecorated, Form 2	1	Terminal Late Archaic	Aves	radius diaphysis	17.5	9	4	Short tubular bead from hawk-sized bird. Minimal modification with grinding to smooth ends. Medium polish from hide with hair.
bone bead fragment, undecorated, Form 2	1	Terminal Late Archaic	Aves	indeterminate long bone	12	8	3	Short tubular bead from hawk-sized bird. Minimal modification to very thin-walled element with grinding to smooth ends. Medium polish from hide with hair.
bone bead, undecorated, Form 2	1	Terminal Late Archaic	*Buteo* sp.	radius diaphysis	12	7.5	7	Short, narrow tubular bead. Has bright non-invasive polish on high points and ends, with rounding of ends typical of wear from contact with hide with hair.
bone bead, undecorated, Form 2	1	Terminal Late Archaic	*Buteo* sp.	radius diaphysis	19.5	7.5	6.5	Short, narrow thin-walled tubular bead with triangular cross-section and smooth surface texture. Crude groove and snap fractures on both ends, ends smoothed, with surface polish.. Has medium invasive polish with rounding of high points, common micro-pitting, and round-edged striations typical of wear from contact with dry hide.

Form	#	Cultural Context	Taxon	Element	Length (mm)	Width (mm)	Thick-ness (mm)	Comments
bone bead fragment, undecorated, Form 2	1	Late Archaic	Accipitridae	ulna diaphysis	16	7	6	Short, narrow tubular bead. No additional modification to element. Medium slightly invasive polish and rounding of high points from dry hide.
bone bead fragment, undecorated, Form 2	1	Middle Archaic	Aves	radius diaphysis	19.5	5	4.5	Short, narrow tubular bead from large hawk-sized bird. Minimal modification with grinding to smooth ends. Has bright invasive abrasive polish with internal and external rounding of ends typical of wear from hide with hair.
bone bead fragment, undecorated, Form 2	1	Middle Archaic	Aves	indeterminate long bone	16	9	3	Short, narrow tubular bead from large hawk-sized bird. Minimal additional modification.
bone bead, undecorated, Form 2	1	Middle Archaic	*Buteo* sp.	ulna diaphysis	17.5	6.5	6	Short, narrow tubular bead from large hawk-sized bird. Minimal modification to very thin-walled element. Has bright invasive polish with internal and external rounding of ends typical of wear from dry hide.

Form	#	Cultural Context	Taxon	Element	Length (mm)	Width (mm)	Thick-ness (mm)	Comments
bone bead, undecorated, Form 3	1	Terminal Late Archaic	Accipitridae	indeterminate long bone	19.5	8	3.5	Short, narrow tubular bead. Additional modification to very thin-walled element by grinding and polishing. Bright invasive polish with rounding of high points and micro-pitting typical of dry hide.
bone bead, undecorated, Form 3	1	Terminal Late Archaic	*Buteo* sp.	humerus diaphysis	18.5	8.5	5.5	Short, narrow tubular bead from medium-sized hawk. Additional modification to very thin-walled element included longitudinal scraping. Has medium non-invasive polish with rounding of high points typical of wear from contact with silica-rich plants.
bone bead, undecorated, Form 3	1	Terminal Late Archaic	*Buteo* sp.	ulna diaphysis	18	8	6	Short, narrow tubular bead from large-sized hawk. Additional modification to very thin-walled element included longitudinal scraping. Has bright invasive polish with internal and external rounding of ends typical of wear from dry hide.

Form	#	Cultural Context	Taxon	Element	Length (mm)	Width (mm)	Thick-ness (mm)	Comments
bone bead, undecorated, Form 3	1	Terminal Late Archaic	*Buteo* sp.	tibiotarsus diaphysis	19	7	6	Short, narrow tubular bead from large-sized hawk. Additional modification included grinding to smooth ends and surface. Has bright invasive polish with internal and external rounding of ends, common micro-pitting, and transverse round-edged striations typical of wear from dry hide.
bone bead, undecorated, Form 3	1	Terminal Late Archaic	*Buteo* sp.	radius diaphysis	13.5	9	6.5	Short, narrow tubular bead from large-sized hawk. Additional longitudinal scraping modification to smooth ends and surface. Has bright invasive polish with of high points and internal and external rounding of ends typical of wear from dry hide.
bone bead, undecorated, Form 3	1	Late Archaic	Accipitridae	humerus diaphysis	9	8.5	8	Short, narrow tubular bead. Additional longitudinal scraping modification to very thin-walled element with grinding to smooth ends. Has bright invasive polish with internal and external rounding of ends typical of wear from dry hide.

Form	#	Cultural Context	Taxon	Element	Length (mm)	Width (mm)	Thick-ness (mm)	Comments
bone bead, undecorated, Form 3	1	Late Archaic	*Buteo* sp.	radius diaphysis	17.5	8	7	Short, narrow tubular bead. Additional modification to very thin-walled element included longitudinal scraping. Has medium non-invasive polish with rounding of high points typical of wear from contact with silica-rich plants.
bone bead, undecorated, Form 3	1	Late Archaic	*Buteo* sp.	radius diaphysis	18	7	5	Short, narrow tubular bead. Additional modification to very thin-walled element included longitudinal scraping. Has bright invasive polish with rounding of high points typical of wear from dry hide.
bone bead, undecorated, Form 4	1	Terminal Late Archaic	Accipitridae	ulna diaphysis	13.5	10	8.5	Short, medium width tubular bead. Minimal modification to ends of element by grinding. Medium invasive polish with rounding of high points typical of dry hide.
bone bead fragment, undecorated, Form 4	1	Terminal Late Archaic	Aves	humerus diaphysis	18	10	8	Short, medium width tubular bead from large bird. Minimal modification to very thin-walled element with grinding to smooth ends. Has bright invasive polish with internal/external rounding of ends and micro-pitting typical of wear from dry hide.

Form	#	Cultural Context	Taxon	Element	Length (mm)	Width (mm)	Thick-ness (mm)	Comments
bone bead fragment, undecorated, Form 4	1	Terminal Late Archaic	*Buteo* sp.	humerus diaphysis	15	10	5.5	Short, medium width tubular bead from large bird. Minimal modification to very thin-walled element with grinding to smooth ends. Medium non-invasive polish with internal/external rounding of ends typical of wear from contact with silica-rich plants.
bone bead, undecorated, Form 4	1	Terminal Late Archaic	*Buteo* sp.	radius diaphysis	16	10	8	Short, medium width tubular bead from large bird. Minimal modification to very thin-walled element with grinding to smooth ends. Medium non-invasive polish with internal/external rounding of ends typical of wear from contact with silica-rich plants.
bone bead fragment, undecorated, Form 5	1	Terminal Late Archaic	*Buteo* sp.	humerus diaphysis	18	10.5	8	Short, medium width tubular bead. Additional modification to bead by longitudinal scraping and grinding/polishing ends. Medium invasive polish with rounding of high points and micro-pitting typical of dry hide.

Form	#	Cultural Context	Taxon	Element	Length (mm)	Width (mm)	Thick-ness (mm)	Comments
bone bead, undecorated, Form 6	1	Terminal Late Archaic	Falconiformes	radius diaphysis	14	12	10	Short, medium width tubular bead from large hawk or eagle-sized element with remnant interosseus crest. Additional modification to very thin-walled element by grinding and polishing. Bright invasive polish with rounding of high points and ends typical of dry hide wear.
bone bead, undecorated, Form 6	1	Terminal Late Archaic	*Meleagris gallapavo*	humerus, distal diaphysis	17	12	9	Short, medium width tubular bead from large hawk. Longitudinal scraping evident. Has bright invasive polish with internal/external rounding of ends and common micro-pitting typical of wear from dry hide. Transverse, round-edged striations also visible at high magnification.
bone bead, undecorated, Form 6	1	Middle Archaic	*Buteo* sp.	radius diaphysis	17.5	11	8	Short, medium width tubular bead from large hawk-sized bird. Minimal modification to very thin-walled element. Has bright invasive polish with internal and external rounding of ends typical of wear from dry hide.

Form	#	Cultural Context	Taxon	Element	Length (mm)	Width (mm)	Thick-ness (mm)	Comments
bone bead fragment, undecorated, Form 7	1	Terminal Late Archaic	Aves	indeterminate long bone	22	6	2.5	Medium tubular bead from large hawk-sized bird. Minimal modification to very thin-walled element with grinding to smooth ends. Has bright invasive polish with internal and external rounding of ends typical of wear from dry hide.
bone bead fragment, undecorated, Form 7	1	Late Archaic	*Buteo* sp.	ulna diaphysis	24.5	7	8	Medium tubular bead from thin-walled bone with triangular cross-section and coarse surface texture (hawk-sized ulna with quill knob). Ends are raggedly snapped. Has medium invasive polish with rounding of high points and ends typical of wear from dry hide.
bone bead fragment, undecorated, Form 7	1	Late Archaic	*Buteo* sp.	tibiotarsus diaphysis	22	8.5	7	Medium tubular bead from large hawk-sized bird. Minimal modification to very thin-walled element. Has bright invasive polish with internal and external rounding of ends typical of wear from dry hide.

Form	#	Cultural Context	Taxon	Element	Length (mm)	Width (mm)	Thick-ness (mm)	Comments
bone bead fragment, undecorated, Form 7	1	Late Archaic	*Buteo* sp.	humerus diaphysis	28	6.5	5.5	Medium tubular bead from large hawk-sized bird. Minimal modification to very thin-walled element. Has bright invasive polish with internal and external rounding of ends typical of wear from dry hide.
bone bead fragment, undecorated, Form 8	1	Terminal Late Archaic	Aves	indeterminate long bone	27	7	3	Medium tubular bead from hawk-sized bird. Additional longitudinal scraping modification to very thin-walled element with grinding to smooth ends. Has bright invasive polish with internal and external rounding of ends typical of wear from dry hide.
bone bead, undecorated, Form 8	1	Terminal Late Archaic	*Buteo* sp.	ulna diaphysis	20	7	6	Medium tubular bead from medium-sized hawk. Additional longitudinal scraping modification, but no use wear.
bone bead, undecorated, Form 8	1	Terminal Late Archaic	*Buteo* sp.	femur diaphysis	25	9.5	7.5	Medium tubular bead from medium-sized hawk. Additional longitudinal scraping modification. Has bright non-invasive polish with limited rounding of high points and few multidirectional striations typical of wear from silica-rich plants.

Form	#	Cultural Context	Taxon	Element	Length (mm)	Width (mm)	Thick-ness (mm)	Comments
bone bead, undecorated, Form 8	1	Terminal Late Archaic	*Buteo* sp.	tibiotarsus diaphysis	21	7	6	Medium tubular bead from medium-sized hawk. Additional longitudinal scraping modification, but no apparent use wear.
bone bead, undecorated, Form 8	1	Terminal Late Archaic	*Buteo* sp.	tibiotarsus diaphysis	24	8.5	6.5	Medium tubular bead from hawk-sized bird. Additional longitudinal scraping modification to very thin-walled element with grinding to smooth ends. Has bright non-invasive polish with limited rounding of high points typical of wear from silica-rich plants.
bone bead fragment, undecorated, Form 8	1	Late Archaic	*Buteo* sp.	tibiotarsus diaphysis	21	8	4	Medium tubular bead from hawk-sized bird. Additional longitudinal scraping modification thinned and smoothed element. Has bright invasive polish with internal and external rounding of ends typical of wear from dry hide.
bone bead fragment, undecorated, Form 8	1	Late Archaic	*Buteo* sp.	ulna diaphysis	20	7	6	Medium tubular bead from hawk-sized bird. Additional longitudinal scraping modification thinned and smoothed element. Has medium invasive polish with internal and external rounding of ends typical of wear from dry hide.

Form	#	Cultural Context	Taxon	Element	Length (mm)	Width (mm)	Thick-ness (mm)	Comments
bone bead fragment, undecorated, Form 8	1	Late Archaic	*Buteo* sp.	ulna diaphysis	22.5	6.5	6	Medium tubular bead from hawk-sized bird. Additional longitudinal scraping modification thinned and smoothed element. Has bright invasive polish with external rounding of ends typical of wear from wet hide.
bone bead, undecorated, Form 9	1	Late Archaic	*Buteo* sp.	radius, medial diaphysis	23.5	9.5	8	Medium tubular bead from large hawk-sized bird with additional longitudinal scraping, grinding and polishing modification. Has bright invasive polish with internal and external rounding of ends with oblique and transverse striations typical of wear from dry hide.
bone bead fragment, undecorated, Form 10	1	Terminal Late Archaic	Aves	indeterminate long bone	20	10	3	Medium tubular bead from large hawk-sized bird. Minimal modification to very thin-walled element with grinding to smooth ends. Has bright invasive polish with internal and external rounding of ends typical of wear from dry hide.

Form	#	Cultural Context	Taxon	Element	Length (mm)	Width (mm)	Thick-ness (mm)	Comments
bone bead fragment, undecorated, Form 10	1	Terminal Late Archaic	Accipitridae	ulna diaphysis	23	10.5	7	Medium tubular bead from large hawk. Minimal modification to very thin-walled element with grinding to smooth ends. Has medium invasive polish with internal/external rounding of ends typical of wear from dry hide.
bone bead fragment, undecorated, Form 10	1	Terminal Late Archaic	*Buteo* sp.	tibiotarsus diaphysis	27	12	6.5	Medium tubular bead from medium-sized hawk. Minimal additional modification to element. Has bright non-invasive polish on high points typical of wear from contact with silica-rich plants.
bone bead, undecorated, Form 10	1	Middle Archaic	*Buteo* sp.	radius diaphysis	28	11	8	Medium tubular bead from medium-sized hawk. Minimal additional modification to element. Has bright non-invasive polish on high points typical of wear from contact with silica-rich plants.

Form	#	Cultural Context	Taxon	Element	Length (mm)	Width (mm)	Thick-ness (mm)	Comments
bone bead, undecorated, Form 11	1	Terminal Late Archaic	*Buteo* sp.	radius diaphysis	24	10	8	Medium tubular bead from large hawk-sized element. Additional modification to element by scraping, with grinding and polishing of ends. Medium non-invasive polish with rounding of high points and ends typical of wear from contact with silica-rich plants.
bone bead fragment, undecorated, Form 11	1	Terminal Late Archaic	*Buteo* sp.	radius diaphysis	26	10	7	Medium tubular bead from large hawk or eagle-sized element. Additional modification to element by scraping, with grinding and polishing of ends. Bright invasive polish with rounding of high points and ends, micro-pitting, and round-edged striations typical of dry hide wear.
bone bead fragment, undecorated, Form 11	1	Middle Archaic	Aves	indeterminate long bone	25	10	2	Medium tubular bead from medium hawk-sized bird. Minimal modification to very thin-walled element with grinding to smooth ends. Has bright invasive polish with internal and external rounding of ends typical of wear from dry hide.

Form	#	Cultural Context	Taxon	Element	Length (mm)	Width (mm)	Thick-ness (mm)	Comments
bone bead fragment, undecorated, Form 11	1	Middle Archaic	Falconiformes	tibiotarsus diaphysis	25	15	9	Medium tubular bead from very large hawk or eagle-sized element. Only one end of blank has groove and snap termination. Additional modification to grinding and polishing. Bright invasive polish with rounding of high points and ends plus faint multi-directional striations typical of dry hide wear.
bone bead fragment, undecorated, Form 12	1	Late Archaic	Falconiformes	tibiotarsus diaphysis	14	12	10	Medium tubular bead from large hawk or eagle-sized element. Minimal modification to moderately thick-walled element by grinding and polishing of ends. Bright invasive polish with rounding of high points and ends typical of dry hide wear.
bone bead, undecorated, Form 12	1	Middle Archaic	*Buteo* sp.	radius diaphysis	28	11	8	Medium tubular bead from large hawk-sized element. Minimal modification to element. Medium non-invasive polish with rounding of high points and ends typical of wear from contact with silica-rich plants.

Form	#	Cultural Context	Taxon	Element	Length (mm)	Width (mm)	Thick-ness (mm)	Comments
bone bead fragment, undecorated, Form 12	1	Middle Archaic	*Meleagris gallapavo*	humerus diaphysis	26	10	6	Medium tubular bead. Minimal modification to moderately thick-walled element by grinding and polishing of ends. Bright invasive polish with rounding of high points and ends, with common micro-pitting typical of dry hide wear.
bone bead fragment, undecorated, Form 13	1	Terminal Late Archaic	*Buteo* sp.	radius diaphysis	32.5	7	3	Long tubular bead. Minimal modification to thin-walled element by grinding and polishing of ends. Bright invasive polish with rounding of high points and ends, with common micro-pitting typical of dry hide wear.
bone bead fragment, undecorated, Form 13	1	Terminal Late Archaic	*Buteo* sp.	radius diaphysis	39	7	4	Long tubular bead, split longitudinally, and has 2 partial transverse grooves incised 16 mm from distal end. Modification to thin-walled element by scraping, then grinding and polishing of ends. Medium invasive polish with rounding of high points and ends, with common micro-pitting typical of dry hide wear.

Form	#	Cultural Context	Taxon	Element	Length (mm)	Width (mm)	Thick-ness (mm)	Comments
bone bead fragment, undecorated, Form 13	1	Late Archaic	*Buteo* sp.	radius diaphysis	40	12	10.5	Long tubular bead. Modification to thin-walled element by scraping, then grinding and polishing of ends. Bright invasive polish with slight rounding of high points and ends, with transverse striations typical of wear from hide with hair.
bone bead fragment, undecorated, Form 13	1	Middle Archaic	*Buteo* sp.	tibiotarsus diaphysis	34	7	8	Long tubular bead from medium – large hawk, split longitudinally. Modification to thin-walled element by scraping, then grinding and polishing of ends. Medium bright invasive polish with rounding of high points and ends typical of dry hide wear.
bone bead, undecorated, Form 14	1	Terminal Late Archaic	*Lepus californicus*	tibia distal diaphysis	7	6	5.5	Short, narrow tubular bead from jackrabbit. Minimal additional modification, with ends ground. Bright, invasive polish with rounding of high points and limited micro-pitting typical of dry hide wear.

Form	#	Cultural Context	Taxon	Element	Length (mm)	Width (mm)	Thick-ness (mm)	Comments
bone bead, undecorated, Form 14	1	Terminal Late Archaic	Mammalia	tibia distal diaphysis	14	5.5	5.5	Short, narrow tubular bead manufactured from small fox or jackrabbit-sized mammal. Minimal additional modification. Medium, invasive polish with rounding of high points and limited micro-pitting typical of dry hide wear.
bone bead, undecorated, Form 14	1	Terminal Late Archaic	*Sylvilagus* sp.	tibia diaphysis	15	5	4	Short, narrow tubular bead from cottontail. Minimal additional modification. Bright, invasive polish with rounding of high points and ends typical of dry hide wear.
bone bead, undecorated, Form 14	1	Terminal Late Archaic	*Sylvilagus* sp.	radius diaphysis	16	4	3	Short, narrow tubular bead from juvenile cottontail. Minimal additional modification. Bright, invasive polish with rounding of ends typical of dry hide wear.
bone bead, undecorated, Form 14	1	Terminal Late Archaic	*Sylvilagus* sp.	tibia diaphysis	10.5	5	4	Short, narrow tubular bead from cottontail. Minimal additional modification. Medium, non-invasive polish with rounding of high points typical of wear from contact with silica-rich plants.

Form	#	Cultural Context	Taxon	Element	Length (mm)	Width (mm)	Thick-ness (mm)	Comments
bone bead, undecorated, Form 14	1	Late Archaic	*Lepus californicus*	tibia diaphysis	19	6.5	4	Short, narrow tubular bead from jackrabbit. Minimal additional modification. Bright, invasive polish with transverse striations and limited micro-pitting typical of dry hide wear. Osteons visible.
bone bead, undecorated, Form 14	1	Late Archaic	*Lepus californicus*	radius diaphysis	13	5	4	Short, narrow tubular bead from jackrabbit. Minimal additional modification. Bright, invasive polish with multi-directional smooth-edged striations and limited micro-pitting typical of dry hide wear.
bone bead, undecorated, Form 14	1	Late Archaic	*Lepus californicus*	phalange	19	5.5	4	Short, narrow tubular bead from juvenile jackrabbit. Minimal additional modification. Burned, obscuring use wear.
bone bead fragment, undecorated, Form 14	1	Late Archaic	*Lepus californicus*	indeterminate long bone	14	5	3	Short, narrow tubular bead from jackrabbit. Minimal additional modification. Medium, non-invasive polish on high points typical of wear from contact with silica-rich plants.
bone bead, undecorated, Form 14	1	Late Archaic	*Sylvilagus* sp.	humerus diaphysis	18	5	4	Short, narrow tubular bead from cottontail. Minimal additional modification by grinding on one end. Bright, invasive polish with rounding of ends typical of dry hide wear.

Form	#	Cultural Context	Taxon	Element	Length (mm)	Width (mm)	Thick-ness (mm)	Comments
bone bead, undecorated, Form 14	1	Late Archaic	*Sylvilagus* sp.	radius diaphysis	16	4.8	3.5	Short, narrow tubular bead from cottontail. Minimal additional modification. Bright, non-invasive polish with rounding of high points typical of wear from contact with silica-rich plants.
bone bead, undecorated, Form 14	1	Late Archaic	*Sylvilagus* sp.	radius diaphysis	15	5	4	Short, narrow tubular bead from cottontail. Minimal additional modification. Bright, non-invasive polish with rounding of high points on ends typical of wear from contact with silica-rich plants.
bone bead, undecorated, Form 14	1	Late Archaic	*Sylvilagus* sp.	tibia diaphysis	18	6	4	Short, narrow tubular bead from cottontail. Minimal additional modification. Medium, invasive polish with minor rounding of high points and ends typical of dry hide wear.
bone bead fragment, undecorated, Form 14	1	Middle Archaic	*Lepus californicus*	tibia diaphysis	17	8	5	Short, narrow tubular bead from jackrabbit. Modification by longitudinal scraping. Bright non-invasive polish on high points with limited end rounding typical of wear of wear from contact with silica-rich plants.

Form	#	Cultural Context	Taxon	Element	Length (mm)	Width (mm)	Thick-ness (mm)	Comments
bone bead, undecorated, Form 15	1	Terminal Late Archaic	*Lepus californicus*	ulna diaphysis	8	8	6	Short, narrow tubular bead from jackrabbit. Modification by longitudinal scraping. One end has groove/snap fracture ground smooth; the other is unmodified. Bright, slightly invasive polish with rounding of ends and on high points typical of wear from contact with silica-rich plants.
bone bead, undecorated, Form 15	1	Terminal Late Archaic	*Lepus californicus*	radius diaphysis	14.5	5.5	4	Short, narrow tubular bead from jackrabbit. Modification by longitudinal scraping. Bright, invasive polish with rounding of ends typical of wear from sinew.
bone bead, undecorated, Form 15	1	Terminal Late Archaic	*Lepus californicus*	phalange	12.5	4.5	4	Short, narrow tubular bead from jackrabbit. Modification by longitudinal scraping. Bright, slightly invasive polish with rounding of ends and on high points typical of wear from contact with silica-rich plants. Striations have round edges.
bone bead, undecorated, Form 15	1	Terminal Late Archaic	*Lepus californicus*	tibia diaphysis	8	7	7	Short, narrow tubular bead from jackrabbit. Modification by longitudinal scraping. Medium, non-invasive polish on high points typical of wear from contact with silica-rich plants.

Form	#	Cultural Context	Taxon	Element	Length (mm)	Width (mm)	Thick-ness (mm)	Comments
bone bead, undecorated, Form 15	1	Terminal Late Archaic	*Lepus californicus*	tibia diaphysis	16	5	5	Short, narrow tubular bead from jackrabbit. Modification by longitudinal scraping. Bright, invasive polish with limited rounding of high points and micro-pitting typical of dry hide wear.
bone bead, undecorated, Form 15	1	Terminal Late Archaic	*Lepus californicus*	tibia, distal diaphysis	14	6	5	Short, narrow tubular bead from jackrabbit. Modification by extensive longitudinal scraping to smooth surface. Bright, invasive polish with limited rounding of high points and limited micro-pitting typical of dry hide wear.
bone bead, undecorated, Form 15	1	Terminal Late Archaic	*Lepus californicus*	radius diaphysis	17.5	8	7	Short, narrow tubular bead from jackrabbit. Modification by longitudinal scraping. Medium, non-invasive polish on high points typical of wear from contact with silica-rich plants.
bone bead, undecorated, Form 15	1	Terminal Late Archaic	*Lepus californicus*	radius diaphysis	19	7.5	6.5	Short, narrow tubular bead from jackrabbit. Modification by longitudinal scraping. Medium, non-invasive polish with limited rounding on high points typical of wear from contact with silica-rich plants.

Form	#	Cultural Context	Taxon	Element	Length (mm)	Width (mm)	Thick-ness (mm)	Comments
bone bead, undecorated, Form 15	1	Terminal Late Archaic	*Lepus californicus*	radius diaphysis	14.5	5.5	4	Short, narrow tubular bead from jackrabbit. Modification by longitudinal scraping. Bright, invasive polish with rounding of high points and ends typical of dry hide wear.
bone bead, undecorated, Form 15	1	Terminal Late Archaic	*Lepus californicus*	tibia diaphysis	16	5	5	Short, narrow tubular bead from jackrabbit. Modification by longitudinal scraping. Limited bright, invasive polish on high points typical of dry hide wear.
bone bead, undecorated, Form 15	1	Terminal Late Archaic	*Lepus californicus*	ulna diaphysis	16	6	5	Short, narrow tubular bead from jackrabbit. Modification by longitudinal scraping. Medium, bright non-invasive polish on high points typical of wear from contact with silica-rich plants.
bone bead fragment, undecorated, Form 15	1	Terminal Late Archaic	*Lepus californicus*	ulna diaphysis	19.5	6	3	Short, narrow tubular bead from jackrabbit. Modification by longitudinal scraping. Bright non-invasive polish with slight rounding of high points typical of wear from hide with hair.

Form	#	Cultural Context	Taxon	Element	Length (mm)	Width (mm)	Thick-ness (mm)	Comments
bone bead, undecorated, Form 15	1	Terminal Late Archaic	*Lepus californicus*	tibia, distal diaphysis	15.5	6	5	Short, narrow tubular bead from jackrabbit. Modification by longitudinal scraping. Bright, invasive polish, rounding of high points and ends, common micro-pitting, and smooth-edged striations typical of dry hide wear.
bone bead, undecorated, Form 15	1	Terminal Late Archaic	Mammalia	indeterminate long bone	18	7	3	Short, narrow tubular bead from small - medium mammal. Modification by longitudinal scraping. Bright, continuous, invasive polish, with common micro-pitting, and slight end rounding typical of wear from dry hide.
bone bead, undecorated, Form 15	1	Terminal Late Archaic	Mammalia	indeterminate long bone	14	7	2.5	Short, narrow tubular bead from small - medium mammal. Modification by longitudinal scraping. Bright, continuous, invasive polish, with common, randomly-oriented striations typical of wear from dry hide.
bone bead, undecorated, Form 15	1	Terminal Late Archaic	*Sylvilagus* sp.	ulna diaphysis	15	5	3.5	Short, narrow tubular bead from cottontail. Modification by longitudinal scraping. Bright, invasive polish with rounding of high points and ends typical of dry hide wear.

Form	#	Cultural Context	Taxon	Element	Length (mm)	Width (mm)	Thick-ness (mm)	Comments
bone bead, undecorated, Form 15	1	Terminal Late Archaic	*Sylvilagus* sp.	radius diaphysis	15	6	5	Short, narrow tubular bead from cottontail. Modification by longitudinal scraping. Bright, non-invasive polish with rounding of ends typical of wear from contact with silica-rich plants.
bone bead, undecorated, Form 15	1	Late Archaic	Canidae	radius diaphysis	16	7	5.5	Short, narrow tubular bead from fox-sized canid. Modification by longitudinal scraping. Bright, non-invasive polish on high points typical of wear from contact with silica-rich plants.
bone bead, undecorated, Form 15	1	Late Archaic	*Lepus californicus*	tibia, diaphysis	15	6	5.5	Short, narrow tubular bead from jackrabbit. Modification by longitudinal scraping. Light slightly invasive polish present with unknown cause.
bone bead, undecorated, Form 15	1	Late Archaic	*Lepus californicus*	tibia diaphysis	17	6	5.5	Short, narrow tubular bead from subadult jackrabbit. Modification by longitudinal scraping. Medium bright invasive polish with rounding of high points and ends, multi-directional striations typical of dry hide wear.

Form	#	Cultural Context	Taxon	Element	Length (mm)	Width (mm)	Thick-ness (mm)	Comments
bone bead, undecorated, Form 15	1	Late Archaic	*Lepus californicus*	radius diaphysis	12	7	6	Short, narrow tubular bead from subadult jackrabbit. Modification by longitudinal scraping. Burned, obscuring use wear.
bone bead, undecorated, Form 15	1	Late Archaic	*Sylvilagus* sp.	tibia diaphysis	14.5	7	4	Short, narrow tubular bead from cottontail. Modification by longitudinal scraping. Bright, non-invasive polish on high points with end rounding typical of wear from contact with silica-rich plants.
bone bead, undecorated, Form 15	1	Late Archaic	*Sylvilagus* sp.	tibia diaphysis	14	5	3	Short, narrow tubular bead from cottontail. Modification by longitudinal scraping. Bright, non-invasive polish on high points with minimal end rounding typical of wear from contact with silica-rich plants.
bone bead fragment, undecorated, Form 15	1	Middle Archaic	*Lepus californicus*	tibia diaphysis	14	8	7	Short, narrow tubular bead from jackrabbit. Modification by longitudinal scraping. Medium, non-invasive polish typical of wear from contact with silica-rich plants.

Form	#	Cultural Context	Taxon	Element	Length (mm)	Width (mm)	Thick-ness (mm)	Comments
bone bead, undecorated, Form 16	1	Historic – Late Prehistoric	*Lepus californicus*	radius diaphysis	14	5	4.5	Short narrow tubular bead manufactured from jackrabbit. Modification by scraping and grinding. Invasive polish with rounding of ends, typical of wear from dry hide.
bone bead, undecorated, Form 16	1	Historic – Late Prehistoric	*Sylvilagus* sp.	tibia diaphysis	19.5	5	4.5	Short narrow tubular bead manufactured from cottontail. Modification by grinding. Medium, slightly invasive polish with rounding of high points, typical of wear from dry hide.
bone bead, undecorated, Form 16	1	Terminal Late Archaic	*Sylvilagus* sp.	tibia diaphysis	18	4.5	4.5	Short, narrow tubular bead from cottontail. Modification by grinding on one end. Bright, invasive polish with rounding of high points and ends, common micro-pitting, and few micro striations typical of dry hide wear.
bone bead fragment, undecorated, Form 16	1	Terminal Late Archaic	*Lepus californicus*	radius diaphysis	14.5	5.5	4	Short, narrow tubular bead from jackrabbit. Modification by longitudinal scraping, with final end grinding. Bright invasive polish with common micro-pitting and end rounding typical of dry hide wear.

Form	#	Cultural Context	Taxon	Element	Length (mm)	Width (mm)	Thick-ness (mm)	Comments
bone bead, undecorated, Form 16	1	Late Archaic	Canidae	radius diaphysis	12	5	4	Short, narrow tubular bead from small fox-sized canid. Modification by longitudinal scraping, grinding, and polishing. Medium bright invasive polish with rounding of high points and ends, multi-directional striations typical of dry hide wear.
bone bead, undecorated, Form 16	1	Late Archaic	*Lepus californicus*	radius diaphysis	8	8	7	Short, narrow tubular bead from jackrabbit. Modification by longitudinal scraping, with final grinding. Bright, non-invasive polish on high points typical of wear from contact with silica-rich plants
bone bead, undecorated, Form 16	1	Late Archaic	*Lepus californicus*	tibia diaphysis	15	8	7	Short, narrow tubular bead from jackrabbit. Modification by longitudinal scraping, with final grinding on ends. Moderate, slightly invasive polish on high points typical of wear from contact with silica-rich plants

Form	#	Cultural Context	Taxon	Element	Length (mm)	Width (mm)	Thick-ness (mm)	Comments
bone bead, undecorated, Form 16	1	Late Archaic	Mammalia	indeterminate long bone	14.8	5	2	Short, narrow tubular bead from thin-walled element of fox or jackrabbit sized mammal. Modification by longitudinal scraping, grinding, and polishing. Invasive polish with rounding of ends, typical of dry hide wear.
bone bead, undecorated, Form 16	1	Late Archaic	*Sylvilagus* sp.	tibia diaphysis	15	6	5	Short, narrow tubular bead from cottontail. Modification by longitudinal scraping, with grinding on one end. Appears to be unfinished or refitted because other end is not smoothed. Medium, non-invasive polish on high points typical of wear from contact with silica-rich plants
bone bead, undecorated, Form 16	1	Late Archaic	*Sylvilagus* sp.	radius diaphysis	13	6	5	Short narrow tubular bead manufactured from juvenile cottontail. Modification by grinding. Bright, non-invasive polish on high points with rounding of ends typical of wear from contact with silica-rich plants

Form	#	Cultural Context	Taxon	Element	Length (mm)	Width (mm)	Thick-ness (mm)	Comments
bone bead, undecorated, Form 16	1	Late Archaic	*Sylvilagus* sp.	radius diaphysis	19.5	5	4.5	Short narrow tubular bead manufactured from cottontail. Modification by grinding. Medium, slightly invasive polish with minor rounding of ends, typical of wear from dry hide.
bone bead, undecorated, Form 17	1	Terminal Late Archaic	Mammalia	indeterminate long bone	12	7	7	Short, narrow tubular bead from large fox-sized canid. Modification includes grinding and polishing to final shape. Bright, invasive polish with external rounding of ends typical of wear from dry hide.
bone bead, undecorated, Form 18	1	Middle Archaic	Carnivora	ulna diaphysis	12	9	6	Short, narrow tubular bead from bobcat to medium-sized canid carnivore. Modification by longitudinal scraping, then grinding and polishing to final shape. Bright, invasive polish on high points typical of wear from hide with hair.
bone bead, undecorated, Form 19	1	Terminal Late Archaic	*Lepus californicus*	tibia diaphysis	11.5	10.5	9	Short, medium width tubular bead from jackrabbit. Minimal additional modification. Burned, calcined with no remaining surface polish.

Form	#	Cultural Context	Taxon	Element	Length (mm)	Width (mm)	Thick-ness (mm)	Comments
bone bead fragment, undecorated, Form 20	1	Late Archaic	*Lepus californicus*	tibia diaphysis	17	10	7	Short, medium width tubular bead from jackrabbit. Modification by longitudinal scraping, with final grinding on ends. Moderate, slightly invasive polish on high points typical of wear from contact with silica-rich plants
bone bead, undecorated, Form 21	1	Terminal Late Archaic	Carnivora	indeterminate long bone	6	10	9	Short, medium width tubular bead from small fox-sized carnivore. Modification by grinding, and polishing. Invasive polish with rounding of high points and ends and visible osteons of dry hide wear.
bone bead, undecorated, Form 21	1	Terminal Late Archaic	Carnivora	indeterminate long bone	18	11	9	Short, medium width tubular bead from element with cross section similar to radius. Modification includes ends ground and polished to final shape. Non-invasive polish present typical of wear from contact with silica-rich plants.

Form	#	Cultural Context	Taxon	Element	Length (mm)	Width (mm)	Thick-ness (mm)	Comments
bone bead, undecorated, Form 22	1	Historic – Late Prehistoric	Carnivora	radius diaphysis	12	12.5	8	Short, medium width tubular bead from small – medium carnivore, ground and polished to final shape. Bright, invasive polish on internal and external surfaces with rounding of ends. Longitudinal striations present with common micro-pitting and transverse striations typical of wear from hide with hair.
bone bead, undecorated, Form 22	1	Terminal Late Archaic	Canidae	radius diaphysis	16	11	7	Short, medium width tubular bead from medium canid, with ends heavily ground and polished to final shape. Bright, invasive polish, with common micro-pitting typical of wear from dry hide.
bone bead, undecorated, Form 22	1	Terminal Late Archaic	Mammalia	indeterminate long bone	18.5	11	6	Short, medium width tubular bead from medium mammal, with ends ground to final shape and then all polished. Bright, continuous, invasive polish, with common smooth-edged striations, common micro-pitting, and slight end rounding typical of wear from wet hide.

Form	#	Cultural Context	Taxon	Element	Length (mm)	Width (mm)	Thick-ness (mm)	Comments
bone bead, undecorated, Form 22	1	Middle Archaic	Mammalia	indeterminate long bone	17	18	3.5	Short, medium width tubular bead from medium mammal, with ends ground to final shape and then all polished. Bright, invasive polish, with common smooth-edged transverse and oblique striations, typical of wear from dry hide.
bone bead fragment, undecorated, Form 23	1	Late Archaic	Carnivora	tibia diaphysis	16	14.5	6.5	Short, medium width tubular bead fragment from medium – large carnivore, heavily weathered.
bone bead fragment, undecorated, Form 23	1	Late Archaic	Carnivora	radius diaphysis	15.5	10.5	7.5	Short, medium width tubular bead, ground to final shape. Split longitudinally. Invasive polish on internal and external surfaces with rounding of ends typical of wear from dry hide.
bone bead, undecorated, Form 24	1	Terminal Late Archaic	*Lepus californicus*	radius diaphysis	23	6	5.5	Medium, narrow tubular bead from jackrabbit. Minimal additional modification except grinding of ends. Invasive polish with rounding of ends, typical of dry hide wear.

Form	#	Cultural Context	Taxon	Element	Length (mm)	Width (mm)	Thick-ness (mm)	Comments
bone bead, undecorated, Form 24	1	Late Archaic	*Lepus californicus*	tibia diaphysis	20	7	3	Medium, narrow tubular bead manufactured from jackrabbit. Minimal additional modification. Limited non-invasive polish on high points of ends typical of wear of wear from contact with silica-rich plants.
bone bead, undecorated, Form 24	1	Late Archaic	*Lepus californicus*	tibia diaphysis	21	6	3.5	Medium, narrow tubular bead manufactured from jackrabbit. Minimal additional modification. No polish.
bone bead, undecorated, Form 24	1	Late Archaic	*Sylvilagus* sp.	tibia diaphysis	25	6	5.5	Medium, narrow tubular bead manufactured from cottontail. Minimal additional modification. Invasive polish present with rounding of ends typical of dry hide wear.
bone bead, undecorated, Form 24	1	Late Archaic	*Sylvilagus* sp.	tibia diaphysis	29	5	4	Medium, narrow tubular bead manufactured from subadult cottontail. Minimal additional modification. Invasive polish present with rounding of ends typical of dry hide wear.

Form	#	Cultural Context	Taxon	Element	Length (mm)	Width (mm)	Thick-ness (mm)	Comments
bone bead, undecorated, Form 24	1	Late Archaic	*Sylvilagus* sp.	tibia diaphysis	20	5.5	4	Medium, narrow tubular bead manufactured from cottontail. Minimal additional modification. Medium, slightly invasive polish present with minor rounding of ends typical of dry hide wear.
bone bead fragment, undecorated, Form 24	1	Middle Archaic	*Lepus californicus*	tibia diaphysis	23	7.5	7	Medium, narrow tubular bead from jackrabbit. Modification by longitudinal scraping. Bright non-invasive polish on high points with limited end rounding typical of wear of wear from contact with silica-rich plants.
bone bead, undecorated, Form 25	1	Terminal Late Archaic	*Lepus californicus*	tibia diaphysis	22	6.5	4.5	Medium, narrow tubular bead from jackrabbit. Modification by longitudinal scraping. Bright, invasive polish with rounding of high points and ends, common, and micro-pitting typical of dry hide wear.
bone bead, undecorated, Form 25	1	Terminal Late Archaic	*Lepus californicus*	tibia diaphysis	20	8	7	Medium, narrow tubular bead from jackrabbit. Modification by longitudinal scraping. Bright, invasive polish with rounding of high points and ends, common micro-pitting, and smooth round-edged striations typical of dry hide wear.

Form	#	Cultural Context	Taxon	Element	Length (mm)	Width (mm)	Thick-ness (mm)	Comments
bone bead, undecorated, Form 25	1	Late Archaic	*Lepus californicus*	radius diaphysis	20	6.5	5.5	Medium, narrow tubular bead manufactured from jackrabbit. Additional modification by heavy longitudinal scraping to smooth and shape. Bright, invasive polish present with slight rounding of ends and round-edged striations typical of dry hide wear.
bone bead, undecorated, Form 25	1	Late Archaic	*Lepus californicus*	radius diaphysis	22	6	4	Medium, narrow tubular bead manufactured from jackrabbit. Additional modification by heavy longitudinal scraping to smooth and shape. Medium non-invasive polish on high points with end rounding typical of wear of wear from contact with silica-rich plants.
bone bead, undecorated, Form 25	1	Late Archaic	*Lepus californicus*	phalange	20.5	3	3	Medium, narrow tubular bead manufactured from jackrabbit. Additional modification by heavy longitudinal scraping to smooth and shape. Bright, invasive polish present with internal and external rounding of ends typical of dry hide wear.

Form	#	Cultural Context	Taxon	Element	Length (mm)	Width (mm)	Thick-ness (mm)	Comments
bone bead, undecorated, Form 25	1	Late Archaic	*Lepus californicus*	phalange	24	4	4	Medium, narrow tubular bead manufactured from jackrabbit. Additional modification by longitudinal scraping to smooth and shape. Bright, invasive polish present with rounding of ends typical of dry hide wear.
bone bead, undecorated, Form 25	1	Late Archaic	*Sylvilagus* sp.	tibia diaphysis	22	5.5	4	Medium, narrow tubular bead manufactured from cottontail. Additional modification by longitudinal scraping. Medium, invasive polish present with slight rounding of ends typical of dry hide wear.
bone bead, undecorated, Form 26	1	Late Archaic	Canidae	phalange	23	5.5	4	Medium, narrow tubular bead manufactured from fox-sized canid. Exhibits longitudinal scraping modification. Medium non-invasive polish on high points typical of wear of wear from contact with silica-rich plants.
bone bead, undecorated, Form 26	1	Middle Archaic	Canidae	tibia, distal diaphysis	27	8	8	Medium, narrow tubular bead manufactured from fox-sized canid. Burned, but exhibits longitudinal scraping modification. Non-invasive polish typical of wear of wear from contact with silica-rich plants.

Form	#	Cultural Context	Taxon	Element	Length (mm)	Width (mm)	Thick-ness (mm)	Comments
bone bead, undecorated, Form 26	1	Middle Archaic	Mammalia	radius diaphysis	21.5	6.5	6	Medium, narrow tubular bead manufactured from fox or jackrabbit-sized mammal. Exhibits longitudinal scraping modification with final polishing. Non-invasive polish, with oblique and transverse striations typical of dry hide wear.
bone bead, undecorated, Form 27	1	Terminal Late Archaic	*Canis latrans* or *Canis familiaris*	humerus, distal diaphysis	21.5	9.5	7.5	Medium, narrow tubular bead manufactured from large dog or coyote. Exhibits limited surface modification of grinding/polishing on ends. Bright invasive polish with internal and external rounding of ends with common micro-pitting typical of wear from dry hide.
bone bead, undecorated, Form 27	1	Terminal Late Archaic	*Canis latrans* or *Canis familiaris*	radius diaphysis	27	8	7	Medium, narrow tubular bead manufactured from large dog or coyote. Exhibits surface modification of longitudinal scraping, with grinding on ends, and overall polishing. Bright invasive polish with internal and external rounding of ends typical of wear from dry hide.

Form	#	Cultural Context	Taxon	Element	Length (mm)	Width (mm)	Thick-ness (mm)	Comments
bone bead, undecorated, Form 27	1	Middle Archaic	Canidae	radius diaphysis	25	8	7	Medium, narrow tubular bead manufactured from fox-sized canid. Partially burned, but exhibits limited surface modification of grinding/polishing on ends. Medium non-invasive polish with common micro-pitting typical of wear of wear from dry hide.
bone bead, undecorated, Form 27	1	Middle Archaic	Canidae	radius diaphysis	22	9	7.5	Medium, narrow tubular bead manufactured from large fox-sized canid. Exhibits limited surface modification of grinding/polishing on ends. Bright, invasive polish typical of wear of wear from dry hide.
bone bead, undecorated, Form 28	1	Late Archaic	Carnivora	tibia diaphysis	21.5	8	6.5	Medium, narrow tubular bead manufactured from medium-sized carnivore with thick-walled tibia. Minimal additional modification by end grinding. Invasive polish present with rounding of ends typical of wear from wet hide.

Form	#	Cultural Context	Taxon	Element	Length (mm)	Width (mm)	Thick-ness (mm)	Comments
bone bead, undecorated, Form 29	1	Terminal Late Archaic	*Canis latrans* or *Canis familiaris*	radius diaphysis	25	10	7.5	Medium tubular bead manufactured from large dog or coyote. Exhibits limited surface modification of grinding/polishing on ends. Bright invasive polish with internal and external rounding of ends with common micro-pitting typical of wear from dry hide.
bone bead, undecorated, Form 30	1	Terminal Late Archaic	Canidae	tibia, proximal diaphysis	27	10	9	Medium tubular bead manufactured from large fox-sized canid. Surface delaminated and weathered, with carnivore ravaging. Modification includes final shaping using fine grinding. Bright invasive polish with rounding of high points and ends typical of wear from dry hide.
bone bead, undecorated, Form 30	1	Terminal Late Archaic	Carnivora	radius diaphysis	22	10.25	8	Medium tubular bead manufactured from medium-sized carnivore radius in bobcat to coyote range and has sub-triangular cross section. Modification includes longitudinal scraping, with final shaping by grinding. Bright invasive polish with rounding of high points and ends typical of wear from dry hide.

Form	#	Cultural Context	Taxon	Element	Length (mm)	Width (mm)	Thick-ness (mm)	Comments
bone bead, undecorated, Form 30	1	Terminal Late Archaic	Carnivora	humerus diaphysis	30	11.5	10	Medium tubular bead manufactured from large-sized fox element. Modification includes longitudinal scraping, with final shaping of proximal end by grinding. Bright invasive polish with rounding of ends and common micro-pitting, typical of wear from dry hide.
bone bead, undecorated, Form 30	1	Middle Archaic	Carnivora	tibia, proximal diaphysis	23	13	10	Medium tubular bead manufactured from medium-sized carnivore. Modification includes final shaping by grinding and polishing. Bright invasive polish with rounding of ends typical of wear from dry hide.
bone bead fragment, undecorated, Form 31	1	Terminal Late Archaic	*Canis latrans* or *Canis familiaris*	tibia diaphysis	25	12	10.5	Medium tubular bead manufactured from large dog or coyote. Exhibits minimal grinding to smooth both ends.
bone bead, undecorated, Form 32	1	Late Archaic	*Lepus californicus*	tibia, proximal diaphysis	33	6.5	5	Long, narrow tubular bead manufactured from jackrabbit. Minimal additional modification. Medium invasive polish with slight end rounding typical of wear of wear from contact with dry hide.

Form	**#**	**Cultural Context**	**Taxon**	**Element**	**Length (mm)**	**Width (mm)**	**Thick-ness (mm)**	**Comments**
bone bead fragment, undecorated, Form 33	1	Terminal Late Archaic	*Canis latrans* or *Canis familiaris*	radius diaphysis	36	10	7	Long, medium width tubular bead manufactured from large dog or coyote. Exhibits longitudinal scraping on surface. Item burned, obscuring surface polish.
bone bead, undecorated, Form 34	1	Terminal Late Archaic	Carnivora	tibia diaphysis	34.5	10	9.5	Long, medium width tubular bead manufactured from large-sized fox element. Modification includes longitudinal scraping, with final shaping of proximal end by grinding. Medium invasive polish with rounding of ends, typical of wear from dry hide.
bone bead, undecorated, Form 34	1	Terminal Late Archaic	*Canis latrans* or *Canis familiaris*	tibia, distal diaphysis	33	18	11	Long, medium width tubular bead manufactured from large dog or coyote. Exhibits limited surface modification of grinding/polishing on ends. Medium non-invasive polish present, typical of wear from dry hide.

Form	#	Cultural Context	Taxon	Element	Length (mm)	Width (mm)	Thick-ness (mm)	Comments
bone bead fragment, undecorated, Form 34	1	Terminal Late Archaic	*Urocyon cinereoargenteus*	femur diaphysis	30	10	8	Long, medium width tubular bead manufactured from fox. Exhibits surface modification of longitudinal scraping and grinding/polishing on ends. Bright invasive polish present, with internal and external rounding of ends and common micro-pitting, typical of wear from dry hide
bone bead fragment, undecorated, Form 34	1	No Provenience	*Canis latrans* or *Canis familiaris*	humerus diaphysis	40	13	9	Long, medium width tubular bead manufactured from large dog or coyote. Exhibits longitudinal scraping on surface. Moderately developed bright invasive polish with end rounding and common micro-pitting, typical of wear from dry hide.
bone bead fragment, undecorated, Form 35	1	Terminal Late Archaic	Artiodactyla	rib diaphysis	34	7	8	Long, very thick-walled bead with flattened, oval cross-section. Minimal modification to element. Bright non-invasive polish with limited rounding of ends typical of typical of wear from contact with silica-rich plant.

Form	#	Cultural Context	Taxon	Element	Length (mm)	Width (mm)	Thick-ness (mm)	Comments
bone bead fragment, undecorated, Form 35	1	Terminal Late Archaic	Artiodactyla	rib diaphysis	23	11.5	6	Long, very thick-walled bead with flattened, oval cross-section. Minimal modification to element. Bright non-invasive polish on high points with limited rounding of edges typical of typical of wear from contact with silica-rich plant.
bone bead, undecorated, Form 36	1	No Provenience	Carnivora	humerus diaphysis	32	12.5	11	Long, medium width tubular bead from thick-walled element with slight longitudinal curve. Bead manufactured from fox or raccoon-sized element, is slightly burned, and highly polished on ends. It has slight rounding of ends and exhibits bright invasive polish typical of wear from dry hide.
bone bead, undecorated, Form 1 preform manufacturing failure	1	Terminal Late Archaic	Artiodactyla	phalange, distal epiphysis and diaphysis	30	14	14	Longitudinal fracture on dorsal aspect indicates failure during removal of proximal epiphysis from blank by grooving and snapping, following longitudinal scraping of element blank.

Form	#	Cultural Context	Taxon	Element	Length (mm)	Width (mm)	Thick-ness (mm)	Comments
bone bead, undecorated, Form 1 preform	1	Terminal Late Archaic	Artiodactyla	phalange, proximal epiphysis and diaphysis	34	17	15	Distal end removed from blank by grooving and snapping, following longitudinal scraping of element blank. A second annular groove incised 10 mm proximal to distal end. Grinding evident on proximal epiphysis.
bone bead, undecorated, Form 3 preform	1	Middle Archaic	*Buteo* sp.	tibiotarsus, proximal diaphysis	45	7	5	Epiphysis removed from blank by grooving and snapping, following longitudinal scraping of element blank. Distal half is longitudinally scraped. A second annular groove incised 6.5 mm from distal fracture.
bone bead, undecorated, Form 13 preform	1	Late Archaic	Aves	indeterminate long bone	23.5	11.5	4	Large bird. Blank prepared by grooving and snapping, following longitudinal scraping of element.
bone bead, undecorated, Form 13 preform	1	Middle Archaic	Aves	tibiotarsus, medial diaphysis	32	12	4	Large bird. Blank prepared by grooving and snapping, following longitudinal scraping of element.
bone bead, undecorated, Form 25 preform	1	Late Archaic	*Lepus californicus*	tibia diaphysis	81	8	8	Preform for narrow tubular bead manufactured from jackrabbit. Exhibits single annular groove 20 mm from proximal end. Additional modification by longitudinal scraping to smooth and shape.

Form	#	Cultural Context	Taxon	Element	Length (mm)	Width (mm)	Thick-ness (mm)	Comments
bone bead, undecorated, Form 29 or 30 preform	1	Middle Archaic	*Canis latrans* or *Canis familiaris*	humerus diaphysis	22.5	12	10	Context may be more general Late Archaic – Middle Archaic.
bone bead, undecorated, Form 32 preform	1	Terminal Late Archaic	Carnivora?	radius diaphysis	70	6	5	Probable juvenile individual. One end exhibits terminal groove/snap fracture that removed epiphysis. Skinning damage cutmarks visible.
bone bead debitage	1	Terminal Late Archaic	Artiodactyla	phalange, distal epiphysis	20	14	14	Distal end removed from blank by grooving and snapping, following longitudinal scraping of element blank.
bone bead debitage	1	Terminal Late Archaic	Artiodactyla	phalange, proximal epiphysis and diaphysis	17	16	12	Proximal end removed from blank by grooving and snapping, with no other modification evident. Manufactured from juvenile individual.
bone bead debitage	1	Terminal Late Archaic	Artiodactyla	phalange, first, proximal epiphysis	17	18.5	15	Proximal end removed from blank by grooving and snapping, with no other modification evident. Very even cut edges, with one or two parallel cutmarks adjacent to cut edge.

Form	#	Cultural Context	Taxon	Element	Length (mm)	Width (mm)	Thick-ness (mm)	Comments
bone bead debitage	1	Terminal Late Archaic	*Buteo* sp.	humerus, right, distal epiphysis	16.5	22.5	12.5	Manufactured from medium - large hawk. Epiphysis remnant was longitudinally scraped. At least 5 transverse cutmarks parallel terminal groove/snap fracture.
bone bead debitage	1	Terminal Late Archaic	*Buteo* sp.	ulna, right, distal diaphysis	30	16.5	12.5	Manufactured from large hawk. High points have longitudinal scraping evident, and 4 deep transverse cutmarks just proximal to terminal groove/snap fracture.
bone bead debitage	1	Terminal Late Archaic	*Buteo* sp.	tibiotarsus, distal diaphysis and epiphysis	43	15	10	Remnants of two groove/snap fractures on proximal end, with lateral scraping distally.
bone bead debitage	1	Terminal Late Archaic	Canidae	humerus, left, distal diaphysis	33	18.5	16	Manufactured from juvenile individual and exhibits terminal groove/snap fracture. Longitudinal scraping evident on diaphysis, with multiple transverse cutmarks adjacent to terminal fracture.
bone bead debitage	1	Terminal Late Archaic	Canidae	ulna, proximal diaphysis and epiphysis	44.5	17	11	Manufactured from juvenile individual in large fox to medium dog or coyote size range. Longitudinal scraping evident on diaphysis.

Form	#	Cultural Context	Taxon	Element	Length (mm)	Width (mm)	Thick-ness (mm)	Comments
bone bead debitage	1	Terminal Late Archaic	Canidae	femur, proximal diaphysis and epiphysis	32.5	21	14	Exhibits terminal groove/snap fracture with 5+ adjacent transverse cutmarks or partial grooves. No additional modification.
bone bead debitage	1	Terminal Late Archaic	*Canis latrans* or *Canis familiaris*	tibia, right, proximal diaphysis and epiphysis	59.5	29	27	Byproduct of tubular bead manufactured from large dog or coyote. A second partial groove transversely located 5 mm from terminal groove / snap fracture, with 5 interceding deep cutmarks. Exhibits longitudinal scraping on surface, with polish evident on high points.
bone bead debitage	1	Terminal Late Archaic	*Canis latrans* or *Canis familiaris*	tibia, right, proximal diaphysis and epiphysis	45.5	22.5	24	Byproduct of tubular bead manufactured from juvenile large dog or coyote. Diaphysis exhibits longitudinal scraping on surface.
bone bead debitage	1	Terminal Late Archaic	*Canis latrans* or *Canis familiaris*	tibia, proximal diaphysis	79.5	19.5	11	Byproduct of tubular bead manufactured from large dog or coyote, split longitudinally. Diaphysis exhibits longitudinal scraping on distal surface.
bone bead debitage	1	Terminal Late Archaic	*Canis latrans* or *Canis familiaris*	tibia, proximal diaphysis and epiphysis	26	20	18	Byproduct of tubular bead manufactured from large dog or coyote. Diaphysis exhibits longitudinal scraping on medial and distal surface.

Form	#	Cultural Context	Taxon	Element	Length (mm)	Width (mm)	Thick-ness (mm)	Comments
bone bead debitage	1	Terminal Late Archaic	*Canis latrans* or *Canis familiaris*	tibia, right, distal diaphysis and epiphysis	29.5	15	12.5	Byproduct of tubular bead manufactured from juvenile large dog or coyote; extremely pitted with articular surface missing. Diaphysis exhibits transverse cutmarks adjacent to terminal groove/snap fracture.
bone bead debitage	1	Terminal Late Archaic	*Canis latrans* or *Canis familiaris*	humerus, left, distal epiphysis	41	24.5	21	Byproduct of tubular bead manufactured from large dog or coyote; partially root-etched.
bone bead debitage	1	Terminal Late Archaic	*Canis latrans* or *Canis familiaris*	humerus, right, distal epiphysis	24	24	20	Byproduct of tubular bead manufactured from juvenile large dog or coyote.
bone bead debitage	1	Terminal Late Archaic	*Canis latrans* or *Canis familiaris*	femur left, proximal diaphysis and epiphysis	33	29	17	Byproduct of tubular bead manufactured from large dog or coyote. Diaphysis exhibits longitudinal scraping on surface.
bone bead debitage	1	Terminal Late Archaic	*Canis* sp. or *Vulpes* sp.	tibia, right, distal diaphysis and epiphysis	31	17	12	Byproduct of tubular bead manufactured from subadult large fox, dog, or coyote. Epiphyseal plate only partially fused and distal diaphysis retaining coarse surface texture of juvenile. Diaphysis exhibits longitudinal scraping on surface, with 5+ sets of transverse deep cutmarks adjacent to terminal fracture.

Form	#	Cultural Context	Taxon	Element	Length (mm)	Width (mm)	Thick-ness (mm)	Comments
bone bead debitage	1	Terminal Late Archaic	Carnivora	radius, right, distal epiphysis	16	9	6	Exhibits terminal groove/snap fracture and poor bone preservation.
bone bead debitage	1	Terminal Late Archaic	*Lynx rufus*	femur, left, distal diaphysis and epiphysis	36	24	26	Exhibits several sets o f parallel grooves adjacent to terminal groove/snap fracture and poor bone preservation.
bone bead debitage	1	Terminal Late Archaic	*Lynx rufus*	humerus, right, distal diaphysis and epiphysis	35	28	16	Diaphysis exhibits longitudinal scraping on surface and limited polish on high points, with 20 - 25 sets of transverse deep cutmarks adjacent to terminal fracture, one of which encircles element.
bone bead debitage	1	Terminal Late Archaic	Mammalia	rib diaphysis	59	12	7	Manufacturing residue of coyote/dog to large-sized mammal. Terminal groove/snap fracture at last of 5 grooves incised at 3 mm intervals. Bright, non-invasive polish on high points on dorsal aspect. At 30 – 70x magnification, transverse striations are visible with sharp edges. No polish on ventral side of terminal fracture.

Form	#	Cultural Context	Taxon	Element	Length (mm)	Width (mm)	Thick-ness (mm)	Comments
bone bead debitage	1	Terminal Late Archaic	*Odocoileus* sp.	phalange, proximal epiphysis	22	19	15	Proximal end removed from blank by grooving and snapping, with grinding modification evident on distal end and slight non-invasive areas of wear from siliceous stone evident on high points.
bone bead debitage	1	Terminal Late Archaic	*Phalacrocorax* sp.	tibiotarsus, distal diaphysis and epiphysis	33	12	11	Byproduct of tubular bead manufactured from cormorant. Diaphysis exhibits longitudinal scraping on surface.
bone bead debitage	1	Terminal Late Archaic	*Vulpes* sp.	tibia, right, distal epiphysis	22	17.5	13	Byproduct of tubular bead manufactured from fox. Diaphysis exhibits longitudinal scraping on surface, with 2 sets of annular partial grooves and deep cutmarks adjacent to terminal fracture.
bone bead debitage	1	Terminal Late Archaic	*Vulpes* sp.	tibia, right distal epiphysis	17	14	10	Byproduct of tubular bead manufactured from fox. Diaphysis exhibits little additional surface modification.
bone bead debitage	1	Terminal Late Archaic	*Vulpes* sp. or *Urocyon cinereoargenteus*	humerus, right proximal diaphysis and epiphysis	54	20	14.5	Byproduct of tubular bead manufactured from fox. Diaphysis exhibits longitudinal scraping on surface, with little additional surface modification.
bone bead debitage	1	Late Archaic	*Buteo* sp.	radius, left distal epiphysis	15	13	7	Manufactured from medium - large hawk.

Form	#	Cultural Context	Taxon	Element	Length (mm)	Width (mm)	Thick-ness (mm)	Comments
bone bead debitage	1	Late Archaic	*Canis latrans* or *Canis familiaris*	humerus, right distal diaphysis and epiphysis	27	21.5	12	Byproduct of tubular bead manufactured from juvenile large dog or coyote. Diaphysis exhibits longitudinal scraping on surface, with 4+ sets of transverse deep cutmarks adjacent to terminal fracture.
bone bead debitage	1	Middle Archaic	Artiodactyla	phalange, proximal epiphysis	11	19.5	13	Proximal end removed from blank by grooving and snapping, with no other modification evident.
bone bead debitage	1	No Provenience	Carnivora	humerus, distal diaphysis	37	14	8.5	Juvenile medium carnivore in coyote/dog or bobcat size range. Element exhibits scraping proximal to terminal groove/snap fracture. Medium non-invasive polish present typical of wear from silica-rich plants.
bone tube	1	Terminal Late Archaic	Accipitridae	tibiotarsus, proximal diaphysis	28	8.5	7	Manufactured from very large hawk or eagle-sized element. Exhibits longitudinal scraping and has medium non-invasive polish on high points only, typical of wear by contact with silica-rich plants.
bone tube	1	Terminal Late Archaic	Artiodactyla	indeterminate long bone	51	15	10	Scraped, with bright, invasive polish with rounding of high points typical of wear from dry hide.

Form	#	Cultural Context	Taxon	Element	Length (mm)	Width (mm)	Thick-ness (mm)	Comments
bone tube	1	Terminal Late Archaic	*Buteo* sp.	radius diaphysis	38	7.5	6	Manufactured from hawk-sized element. Item has coarse surface texture and exhibits groove/snap fracture on only one end. It has minimal surface modification. Medium non-invasive polish on high points only is typical of wear by contact with silica-rich plants.
bone tube fragment	1	Terminal Late Archaic	*Buteo* sp.	tibiotarsus, left, diaphysis fragment	37	9	7	Manufactured from medium – large hawk with remnant of fibular crest. It has minimal surface modification.
bone tube fragment	1	Terminal Late Archaic	*Buteo* sp.	indeterminate long bone	36	12	6	Manufactured from large long bone with slight curve. It has minimal surface modification.
bone tube fragment	1	Terminal Late Archaic	*Buteo* sp.	ulna, left, diaphysis	63	9	7	Manufactured from medium-sized long bone. It has minimal surface modification. Bright non-invasive polish on high points only is typical of wear by contact with silica-rich plants.
bone tube fragment	1	Terminal Late Archaic	*Canis latrans* or *Canis familiaris*	radius diaphysis	25	10	7	Very limited modification. Minimal surface modification consists of butchering damage.

Form	#	Cultural Context	Taxon	Element	Length (mm)	Width (mm)	Thick-ness (mm)	Comments
bone tube fragment	1	Terminal Late Archaic	Carnivora	tibia, left, proximal diaphysis	52.5	14	11	Modification includes rounding and slight polish on terminal groove/snap fracture. Minimal surface modification consists of butchering damage.
bone tube fragment	1	Terminal Late Archaic	Carnivora	radius diaphysis	70	6	5	Juvenile individual. Minimal surface modification consists of skinning damage.
bone tube fragment	1	Terminal Late Archaic	Carnivora	tibia diaphysis	43.5	10	9	Weathered. Surface modification consists of longitudinal scraping, with medium invasive polish and common micro-pitting from dry hide wear.
bone tube fragment	1	Terminal Late Archaic	Carnivora	humerus diaphysis	48	12.5	10	Juvenile individual. Surface modification consists of longitudinal scraping.
bone tube fragment	1	Terminal Late Archaic	*Lepus californicus*	tibia, right, distal diaphysis	69	7.5	6	Modification includes longitudinal scraping.
bone tube fragment	1	Terminal Late Archaic	*Lepus californicus*	tibia diaphysis	34	7	5.5	Juvenile individual. Surface modification consists of longitudinal scraping.
bone tube fragment	1	Terminal Late Archaic	*Lepus californicus*	tibia, mesial diaphysis	44	8	4	Surface modification consists of grinding, with undesignated patchy diffuse polish present..

Form	#	Cultural Context	Taxon	Element	Length (mm)	Width (mm)	Thick-ness (mm)	Comments
bone tube fragment	1	Terminal Late Archaic	*Lepus californicus*	tibia proximal diaphysis	60.5	7.5	6.5	Surface modification consists of longitudinal scraping and transverse grooving on proximal end. Medium invasive polish typical of dry hide wear present.
bone tube fragment	1	Terminal Late Archaic	*Lepus californicus*	tibia distal diaphysis	79	10	8.5	Minimal surface modification, with no obvious use wear.
bone tube fragment	1	Terminal Late Archaic	*Lepus californicus*	tibia diaphysis	23	7	4	Thick-walled, with longitudinal scraping. Exhibits medium non-invasive polish on high points typical of wear from silica-rich plants.
bone tube fragment	1	Terminal Late Archaic	*Sylvilagus* sp.	radius diaphysis	32	5	4	Thin-walled element, with no additional modification. Exhibits bright invasive polish on ends with slight rounding typical of wear from dry hide.
bone tube fragment	1	Terminal Late Archaic	*Vulpes* sp.	ulna diaphysis	21	8.5	4.5	Surface modification includes no smoothing in addition to longitudinal scraping. Exhibits medium non-invasive polish with slight rounding on ends typical of wear from silica-rich plants.

Form	#	Cultural Context	Taxon	Element	Length (mm)	Width (mm)	Thick-ness (mm)	Comments
bone tube	1	Late Archaic	Accipitridae	ulna diaphysis	54.5	6	5.5	Manufactured from small hawk element. Exhibits grinding and medium invasive polish on ends, typical of wear by contact with dry hide.
bone tube fragment	1	Late Archaic	Aves	radius diaphysis	21	6	5	Manufactured from small hawk-sized element with porous surface. Exhibits longitudinal scraping and has invasive polish on ends only, typical of wear by dry hide.
bone tube fragment	1	Late Archaic	Aves	indeterminate long bone	33	9.5	4	Manufactured from large diameter element, burned. No obvious wear.
bone tube fragment	1	Late Archaic	Aves	indeterminate long bone	41.5	10	2	Manufactured from large bird, burned. No obvious wear.
bone tube fragment	1	Late Archaic	Aves	indeterminate long bone	41	10	5	Manufactured from large bird. Exhibits longitudinal scraping, but no obvious wear.
bone tube fragment	1	Late Archaic	Aves	indeterminate long bone	30	17	4	Manufactured from large bird. Exhibits longitudinal scraping, but no obvious wear.
bone tube fragment	1	Late Archaic	Aves	indeterminate long bone	30	17	4	Manufactured from large bird. Exhibits longitudinal scraping, but no obvious wear.

Form	#	Cultural Context	Taxon	Element	Length (mm)	Width (mm)	Thick-ness (mm)	Comments
bone tube fragment	1	Late Archaic	*Buteo* sp.	indeterminate long bone	36	9	4.5	Medium- large hawk-sized element, burned. Exhibits faint transverse wavy striations from scraping and grinding.
bone tube	1	Late Archaic	Falconiformes	radius diaphysis	64	7	6	Manufactured from large hawk element. Exhibits distal scraping, with additional medium non-invasive polish on high points only, typical of wear by contact with silica-rich plants.
bone tube fragment	1	Late Archaic	*Lepus californicus*	phalange diaphysis	24.5	4.5	3.5	Modification includes longitudinal scraping. Exhibits invasive polish near ends, typical of wear by contact with dry hide.
bone tube fragment	1	Late Archaic	*Lepus californicus*	tibia diaphysis	31	4.5	2	Minimal surface modification. Exhibits minor invasive polish typical of wear by dry hide and siliceous stone.
bone tube fragment	1	Late Archaic	*Lepus californicus*	tibia proximal diaphysis	41	9.5	7	Minimal surface modification. Exhibits medium non-invasive polish on high points and end rounding typical of wear from silica-rich plants.

Form	#	Cultural Context	Taxon	Element	Length (mm)	Width (mm)	Thick-ness (mm)	Comments
bone tube fragment	1	Late Archaic	*Lepus californicus*	radius, left, diaphysis	28	6.5	3	Modification includes longitudinal scraping. Exhibits medium non invasive polish on high points, brighter on ends, typical of wear from silica-rich plants.
bone tube fragment	1	Late Archaic	*Lepus californicus*	radius diaphysis	22.5	5	3	Minimal surface modification., with no obvious use wear.
bone tube fragment	1	Late Archaic	Mammalia	ulna diaphysis	30	6	5	Juvenile medium-sized mammal, with longitudinal scraping and no obvious use wear.
bone tube fragment	1	Late Archaic	*Sylvilagus* sp.	tibia diaphysis	22	5	3.5	Surface modification includes longitudinal scraping, with grinding on one end. Exhibits very limited medium invasive polish with slight rounding on distal end typical of wear from silica-rich plants.
bone tube preform	1	Terminal Late Archaic	Canidae	tibia, distal diaphysis	76	11	11	Manufactured from juvenile fox-sized canid. Modification includes annular groove incised 15 mm from distal terminal groove/snap fracture. Weathered.
bone tube preform	1	Terminal Late Archaic	*Canis* sp.	humerus diaphysis	68	16	10	Modification includes longitudinal scraping.

Table 6.8: Summary of Frequency and Cultural Context for Implement Forms in Arenosa Shelter Bone Artifact Analysis.

Form	Historic - Late Prehistoric (surface - stratum 2)	Terminal Late Archaic (strata 3 - 9)	Late Archaic (strata 10 -11)	Middle Archaic (strata 12 - 30)	No Provenience
antler billet/soft hammer flaker			2		
antler billet/soft hammer flaker fragment			1		
antler chisel		1	1	1	
antler tine tool fragment				1	
antler tine pressure flaking tool fragment				2	
antler tine tool, beveled tip				2	
antler tine tool, rounded tip			1	1	
awl/bodkin fragment		11	1	2	
awl/perforator fragment			2		
beamer/flesher fragment		1		1	
bodkin fragment	1	3	3	3	
bodkin manufacturing debitage					1
bodkin/perforator fragment				1	

Form	Historic - Late Prehistoric (surface - stratum 2)	Terminal Late Archaic (strata 3 - 9)	Late Archaic (strata 10 -11)	Middle Archaic (strata 12 - 30)	No Provenience
expedient tool, butchering		4			
expedient tool, butchering, utilized fish scale	1				
expedient tool, cutting			1		
expedient tool, hide-working		1			
expedient tool fragment, spatulate, bone		1		1	
flesher		1			
needle fragment		3			
perforator		1			
perforator fragment		10	1	2	
perforator fragment, catfish spine		1			
preform, fish hook				1	
pressure flaking tool fragment	1	1			
rib tool fragment	1	1			
spatulate	1	3			
spatulate fragment	14	99	28	29	7
spatulate/ bodkin fragment		5			3

Form	Historic - Late Prehistoric (surface - stratum 2)	Terminal Late Archaic (strata 3 - 9)	Late Archaic (strata 10 -11)	Middle Archaic (strata 12 - 30)	No Provenience
spatulate fragment, catfish spine		6			
spatulate fragment, creaser		1			
spatulate fragment, distally notched				3	
spatulate fragment, incised	1	7		1	
spatulate fragment, narrow	1	3		1	
spatulate/ perforator fragment		3			
spatulate fragment, ulna		5			
turtle bone, utilized				1	
wedge		1			1
woodworking tool/beveled and faceted					1
spatulate manufacturing debitage		6	1	2	
spatulate manufacturing blank failure					1
spatulate refitting debitage fragment		1			

Form	Historic - Late Prehistoric (surface - stratum 2)	Terminal Late Archaic (strata 3 - 9)	Late Archaic (strata 10 -11)	Middle Archaic (strata 12 - 30)	No Provenience
spatulate or perforator preform fragment		1			
spatulate preform fragment		3			
Totals	**21**	**185**	**42**	**55**	**14**

Table 6.9: Frequency, Metric, and Cultural Context Data for Arenosa Shelter Bone Implements and Their Manufacturing Byproducts.

Form	#	Cultural Context	Taxon	Element	Length (mm)	Width (mm)	Thick-ness (mm)	Comments
antler billet, soft hammer flaker	1	Late Archaic	*Odocoileus* sp.	antler beam	130	31	28	Moderately long antler beam fragment from very large deer has ovate cross section with broadly rounded ends ground to shape. Beam has been longitudinally scraped following chopping to remove blank from antler. Thicker end has deep cutmarks on or adjacent to it consistent with use in soft hammer percussion flint knapping. Ends also have slightly invasive polish similar to that produced by dry hide.

Form	#	Cultural Context	Taxon	Element	Length (mm)	Width (mm)	Thick-ness (mm)	Comments
antler billet, soft hammer flaker	1	Late Archaic	*Odocoileus* sp.	antler beam	125	30	23	Moderately long antler beam fragment with broadly rounded ends. One end has two longitudinal grooves adjacent to it that are consistent with use in soft hammer percussion flint knapping. Heavily weathered, with no evident polish.
antler billet, soft hammer flaker fragment	1	Late Archaic	*Odocoileus* sp.	antler beam	52	24	16	Split beam with limited surface modification. Burned, obscuring use wear.
antler chisel	1	Terminal Late Archaic	*Odocoileus* sp.	antler tine	29	10	9	Distal end ground for 13 mm into broadly rounded and beveled 6 mm wide tip. Surface polished. Distal tip edges have wood polish with osteons visible.
antler chisel	1	Late Archaic	*Odocoileus* sp.	antler tine	50	16	13	Distal tip absent, but distal end has been ground through cortex into rough bevel with oval cross section. Tool body scraped during manufacture. Remnant polish on high points with osteons visible typical of wood use wear.
antler chisel	1	Middle Archaic	*Odocoileus* sp.	antler tine	70	16	16	Distal end has rough bevel produced by grinding and/or scraping on upper and lower surfaces, with polish on high points including those of adjacent surface. Burned, obscuring use wear.

Form	#	Cultural Context	Taxon	Element	Length (mm)	Width (mm)	Thick-ness (mm)	Comments
antler tine, pressure flaking tool	1	Middle Archaic	*Odocoileus* sp.	antler tine	22.5	7	7	Bluntly rounded 4.5 mm wide tip with slight bevel and round cross section. Artifact burned/calcined, making exact use wear determination difficult. Battering of tip and slight tear out of lateral edge at tip consistent with pressure flaking wear.
antler tine, pressure flaking tool	1	Middle Archaic	*Odocoileus* sp.	antler tine	56	16	11	Broadly rounded 9 mm wide tip with oval cross section has faint oblique, circumferential, and transverse striations with concentration at tip and along lateral edges near tip. Striations are consistent with wear by siliceous stone in pressure flaking use.
antler tine tool	1	Middle Archaic	*Odocoileus* sp.	antler tine	19	6	6	Poor preservation and heavy carnivore ravaging with no remaining use wear polish. Tool scraped during manufacture.
antler tine tool, beveled tip	1	Middle Archaic	*Odocoileus* sp.	antler tine	39	15	13	Weathered and heavily carnivore ravaged, but retains some rounding and polish on surface. Ovate profile 9 mm wide distal tip beveled by unknown mechanism. Bright non-invasive polish on high points on uneven surface of bevel.
antler tine tool, beveled tip	1	Middle Archaic	*Odocoileus* sp.	antler tine	34.5	10	8.5	Weathered, with little remaining original surface. Distal tip beveled by grinding into 6.5 mm wide

Form	#	Cultural Context	Taxon	Element	Length (mm)	Width (mm)	Thick-ness (mm)	Comments
								rounded profile. Tip has round cross section. Body of tool has flattened areas that were scraped during manufacture.
antler tine tool, rounded tip	1	Late Archaic	*Odocoileus* sp.	antler tine	51	12.5	10	Distal section of 4 mm wide tip ground to a gently rounded profile with a round cross section. Significantly weathered. Medium bright invasive polish with smooth-edged striations typical of use wear from dry hide.
antler tine tool, rounded tip	1	Middle Archaic	*Odocoileus* sp.	antler tine	26	8	7	Surfaces cut and scraped, with 4 mm wide tip ground to a gently rounded profile with a round cross section. Burned, making exact use wear determination difficult. Bright non-invasive polish with rounding of tip and high points present typical of use wear from hide with hair.
awl/bodkin fragment	1	Terminal Late Archaic	Artiodactyla	metacarpal diaphysis	46	13	8	Medial fragment from blank prepared by chopping, with resulting edges ground and polished. Bright non-invasive polish with rounding and transverse, sharp-edged striations present on high points are consistent with use wear from contact with silica-rich plants.

Form	#	Cultural Context	Taxon	Element	Length (mm)	Width (mm)	Thick-ness (mm)	Comments
awl/bodkin fragment	1	Terminal Late Archaic	Artiodactyla	metacarpal diaphysis	27	9	6.5	Latero-medial fragment at transition from medial to distal portion of tool. Tool blank detached by chopping. External surfaces and edges scraped and ground to shape. Artifact burned, making exact use wear determination difficult, but remaining wear is consistent with use wear from contact with silica-rich plants.
awl/bodkin fragment	1	Terminal Late Archaic	Artiodactyla	metapodial diaphysis	36	8	4	Distal fragment of weathered tool with small areas delaminated. Tool blank removal method unknown. Surfaces and edges scraped to shape. Artifact burned, making exact use wear determination difficult. Bright non-invasive polish present with rounding on high points and transverse, sharp-edged striations distally are consistent with use wear from contact with silica-rich plants.
awl/bodkin tip fragment	1	Terminal Late Archaic	Artiodactyla	indeterminate long bone	35	6	4	Tip of long narrow gently tapering distal tool segment with oval cross section. Tip about 3 mm wide, rounded, and gently tapering. Tool blank prepared by grooving and snapping. Surfaces and edges ground to shape. Tip has very shallow tear-out. Bright non-invasive polish present with

Form	#	Cultural Context	Taxon	Element	Length (mm)	Width (mm)	Thick-ness (mm)	Comments
								rounding on high points. Fine sharp-edged longitudinal striations distally and transverse medio-proximally are consistent with use wear from contact with silica-rich plants.
awl/bodkin tip fragment	1	Terminal Late Archaic	Artiodactyla	metacarpal diaphysis	49	8.5	5	Tip of tapering distal tool segment with oval cross section. Tip about 2 mm wide and rapidly expanding. Tool blank prepared by grooving and snapping. Surfaces and edges scraped and then ground to shape. Artifact burned, making exact use wear determination difficult. Bright non-invasive polish present with rounding on high points. Fine transverse sharp-edged striations on lateral edges and both dorsal and ventral aspects consistent with use wear from contact with silica-rich plants.
awl/bodkin tip fragment	1	Terminal Late Archaic	Artiodactyla	indeterminate long bone	38	6.5	4	Tip of tapered distal tool segment with oval cross section. Sharp, slightly beveled tip about 3 mm wide and rapidly expanding. Tool blank prepared by grooving and snapping. Surfaces and edges ground to shape. Surface slightly pitted from weathering. Bright non-invasive polish present with rounding on high points. Osteons

Form	#	Cultural Context	Taxon	Element	Length (mm)	Width (mm)	Thick-ness (mm)	Comments
								visible. Fine longitudinal smooth-edged striations at and near tip, with transverse striations medio-proximally consistent with use wear from contact with wood.
awl/bodkin fragment	1	Terminal Late Archaic	*Odocoileus* sp.	metacarpal, distal epiphysis and diaphysis	72.5	17.5	17.5	Badly weathered medio-proximal segment of tool with ragged distal dry-state fractures. Tool blank prepared by method other than grooving and snapping, possibly chopping. Proximal end ground to shape, exposing cancellous bone. Distal end exhibits chopping damage. Surface slightly pitted. Non-invasive polish present on high points, including cancellous bone on proximal end, typical of use wear from hide with hair.
awl/bodkin fragment	1	Terminal Late Archaic	*Odocoileus* sp.	metacarpal, diaphysis	50	12	6.5	Medio-distal segment of slightly tapered tool. Blank prepared by grooving and snapping. Surfaces and edges scraped, then ground to shape. Surface slightly pitted from weathering. Bright non-invasive polish present with rounding on high points. Fine to medium sharp-edged transverse striations proximally and oblique distally. Ventrally, wide transverse groups of striations and grooves consistent with use wear from contact with

Form	#	Cultural Context	Taxon	Element	Length (mm)	Width (mm)	Thick-ness (mm)	Comments
								silica-rich plants.
awl/bodkin fragment	1	Terminal Late Archaic	*Odocoileus* sp.	metacarpal, diaphysis	18.5	8	5	Medio-distal segment of slightly tapered tool. Blank prepared by unknown method. Surfaces and edges ground to shape. Artifact burned, making exact use wear determination difficult. Osteons visible. Bright non-invasive polish and rounding on high points with fine to medium smooth-edged transverse striations visible, consistent with use wear from contact with wood.
awl/bodkin tip fragment	1	Terminal Late Archaic	*Odocoileus* sp.	metacarpal diaphysis	52	10	6	Relatively narrow tip of tapering distal tool segment with oval cross section. Slightly rounded, tip about 3 mm wide, with tear-out damage. Tool blank prepared by chopping. Surfaces and edges scraped and then ground to shape. Tip has tear-out with polished edges and discoloration. Osteons visible. Bright non-invasive polish and rounding on high points with smooth-edged transverse striations visible medially and proximally, consistent with use wear from contact with wood.

Form	#	Cultural Context	Taxon	Element	Length (mm)	Width (mm)	Thick-ness (mm)	Comments
awl/bodkin tip fragment	1	Terminal Late Archaic	*Odocoileus* sp.	metacarpal diaphysis	23	5	2.5	Gently tapering distal tool segment. Rounded tip about 3 mm wide has oval cross section. Blank prepared by unknown method, with scraping and grinding to shape. Bright non-invasive polish and rounding on high points with visible smooth-edged striations, transverse proximally, oblique distally. Use wear is consistent with wood contact.
awl/bodkin tip fragment	1	Late Archaic	*Odocoileus* sp.	metacarpal diaphysis	46.5	9	4	Tip of tapering distal tool segment with oval cross section. Gently rounded, slightly beveled tip about 2.5 mm wide, but slightly damaged. Tool blank originally prepared by unknown method. Surfaces and edges scraped and then ground to shape. Artifact appears to be reused from broken specimen due to wear on longitudinal fracture. Tip has slight tear-out and discoloration. Bright non-invasive polish present with rounding on high points. Fine transverse sharp-edged striations on lateral edges consistent with use wear from contact with silica-rich plants.
awl/bodkin fragment	1	Middle Archaic	*Odocoileus* sp.	metacarpal diaphysis	32	9.5	6	Latero- distal tool segment. Tool blank prepared by chopping. Surfaces and edges scraped and then ground to shape. Extensive

Form	#	Cultural Context	Taxon	Element	Length (mm)	Width (mm)	Thick-ness (mm)	Comments
								pitting present. Bright non-invasive polish present with rounding on high points. Fine transverse sharp-edged striations consistent with use wear from contact with silica-rich plants.
awl/bodkin fragment	1	Middle Archaic	*Odocoileus* sp.	metacarpal diaphysis	60	12	4	Medio-distal tool segment, missing distal 5 – 10 mm of tip. Distal fracture teardrop shaped. One lateral edge tapering in a smooth, step fashion; the other is roughly straight. Tool blank prepared by chopping. Surfaces and edges scraped and then ground to shape. Extensive pitting present. Bright non-invasive polish present with rounding on high points. Fine transverse, oblique, and longitudinal smooth-edged striations consistent with use wear from contact with dry hide.
awl/perforator fragment	1	Late Archaic	Mammalia	ulna, distal diaphysis	59.5	6	6	Manufactured from medium-sized mammal, but definitely not jackrabbit. Most of tool present, missing distal 5 – 10 mm of tip. Width 3 mm at this point, with approximately round cross section. Post-depositional distal fracture occurred where longitudinal scraping penetrated medullary cavity. Tool blank prepared by

Form	#	Cultural Context	Taxon	Element	Length (mm)	Width (mm)	Thick-ness (mm)	Comments
								grooving and snapping at proximal end. Surfaces and edges scraped to shape. Bright invasive polish present on high points. Fine oblique to longitudinal smooth-edged striations on distal one-third are consistent with use wear from contact with dry hide.
awl/perforator fragment	1	Late Archaic	Artiodactyla	ulna, distal diaphysis	128	10	4.5	Most of long narrow tool present, but missing extreme distal tip and proximal end. Width 2 mm at distal fracture, with constricted, approximately round cross section. Tool blank prepared by longitudinal grooving and snapping of to remove it from larger thin-walled long bone fragment. Surfaces and edges scraped to shape. Bright invasive polish present, especially on high points. Fine oblique smooth-edged striations on medial to proximal outer aspect, with transverse smooth-edged striations present on distal half. Wear is consistent with contact by dry hide.
beamer/flesher	1	Terminal Late Archaic	Artiodactyla	indeterminate long bone	37	9	6	Complete small tool. Wide beveled tip on relatively narrow medium-length tool. Multiple bifacial flakes removed across 9 mm wide distal tip. Blank fashioned from helically fractured bone fragment, then tip

Form	#	Cultural Context	Taxon	Element	Length (mm)	Width (mm)	Thick-ness (mm)	Comments
								section modified by dynamic flaking. Bright polish on high points, with no rounding and no visible striations. Use wear consistent with use wear from meat.
beamer/flesher fragment	1	Middle Archaic	Artiodactyla	scapula, ventral diaphysis	26	13	3	Proximal portion of larger tool. Blank prepared by grooving and snapping, followed by grinding to final shape. Bright invasive polish and rounding on lateral edge and portion of distal tip with visible osteons is consistent with use wear from meat.
bodkin fragment	1	Historic – Late Prehistoric	Artiodactyla	metacarpal, distal epiphysis and diaphysis	53.5	21	14.5	Proximal segment of tool. Tool blank prepared by grooving and snapping. Tool surface scraped to shape, then proximal end ground, exposing cancellous bone. Artifact burned, making exact use wear determination difficult. Bright non-invasive polish present with rounding on high points consistent with use wear from contact with silica-rich plants.
bodkin tip fragment	1	Terminal Late Archaic	Artiodactyla	metacarpal diaphysis	30	11	4.5	Tip of sharply tapering distal tool segment with oval cross section. Slightly damaged, 2.5 mm wide tip has 4 longitudinal spalls present. Three spalls have polish from use wear. Tool blank originally prepared by unknown method.

Form	#	Cultural Context	Taxon	Element	Length (mm)	Width (mm)	Thick-ness (mm)	Comments
								Tool surface scraped, then ground to shape. Artifact burned, making exact use wear determination difficult. Bright invasive polish present with rounding of edges. Pitting common at tip, less common elsewhere. With common fine smooth edged transverse striations. Use wear consistent with contact by wood.
bodkin proximal fragment	1	Terminal Late Archaic	Artiodactyla	metacarpal, distal epiphysis and diaphysis	88	16	16	Medio-proximal segment of tool. Tool blank originally prepared by chopping. Tool surface chopped distally, then condyles ground to shape proximally, exposing cancellous bone. Bright non-invasive polish present on high points, with common sharp-edged transverse striations on outer surface consistent with use wear from contact with silica-rich plants.
bodkin fragment	1	Late Archaic	Artiodactyla	metacarpal, proximal diaphysis	72.5	25.5	17	Medio-proximal portion of tool with significant carnivore ravaging on lateral aspects. Tool blank originally prepared by helical fracture. Tool surface scraped and ground to shape distally. Bright non-invasive polish present on high points, with limited rounding of distal fracture. Sharp-edged transverse striations are common.

Form	#	Cultural Context	Taxon	Element	Length (mm)	Width (mm)	Thick-ness (mm)	Comments
								Use wear is consistent with contact from silica-rich plants.
bodkin fragment	1	Late Archaic	Artiodactyla	metacarpal, distal epiphysis and diaphysis	57	31	20.5	Medio-proximal portion of tool. Tool blank prepared by grooving and snapping. Tool surface scraped to shape medially and distally. Bright invasive polish present with rounding of high points and common micro-pitting consistent with use wear from contact with dry hide.
bodkin fragment	1	Middle Archaic	Artiodactyla	metacarpal, proximal diaphysis	66	12.5	9	Medio-proximal portion of tool. Tool blank prepared by chopping. Tool surface scraped, then ground to shape. Artifact burned, making exact use wear determination difficult. Bright non-invasive polish present with rounding of high points and oblique common fine to medium sharp-edged striations distally on ventral aspect, consistent with contact from silica-rich plants.
bodkin fragment	1	Middle Archaic	Artiodactyla	metacarpal diaphysis	45	10	9	Distal portion of tool exhibiting significant weathering damage, with common pitting and dry-state proximal and distal fractures. Tool blank prepared by unknown method. Tool surface scraped, then ground to shape. Bright non-invasive polish present with

Form	#	Cultural Context	Taxon	Element	Length (mm)	Width (mm)	Thick-ness (mm)	Comments
								rounding of high points and common oblique, fine, sharp-edged striations proximally, consistent with contact from silica-rich plants.
bodkin fragment	1	Terminal Late Archaic	*Odocoileus* sp.	metacarpal diaphysis	67	13	8.5	Medial tool segment. Tool blank prepared by chopping. Surfaces and edges scraped, and subsequent, more extensive, grinding to final shape. Artifact lightly burned and eroded, making exact use wear determination difficult. Bright non-invasive polish with rounding of high points and transverse, fine sharp-edged striations distally, consistent with contact from silica-rich plants.
bodkin fragment	1	Late Archaic	*Odocoileus* sp.	metacarpal, distal diaphysis	39	27	17	Medio-proximal portion of tool manufactured from juvenile individual, missing epiphysis beyond growth plate. Tool blank prepared by grooving and snapping. Surfaces and edges scraped distally, with subsequent, more extensive, grinding to final shape. Artifact lightly burned, making exact use wear determination more difficult. Bright non-invasive polish present with rounding of high points and common transverse, fine to medium, sharp-edged striations distally, consistent with contact

Form	#	Cultural Context	Taxon	Element	Length (mm)	Width (mm)	Thick-ness (mm)	Comments
								from silica-rich plants.
bodkin fragment	1	Middle Archaic	*Odocoileus* sp.	metacarpal, distal epiphysis and diaphysis	92	31	20	Almost complete short, broad tool with obliquely fractured tip. Oval cross section on 5 mm wide tip. Tool blank prepared by grooving and snapping. Surfaces and edges scraped mesially, with subsequent, more extensive, grinding mesially and distally to final shape. Artifact lightly burned distally, making exact use wear determination more difficult. Bright non-invasive polish and rounding of high points present with distal wide, shallow transverse use wear groove and distal fine sharp-edged transverse striations, consistent with contact from silica-rich plants.
bodkin manufacturing debitage	1	No Provenience	*Odocoileus* sp.	metacarpal diaphysis	87	16	9	Tool blank removed by grooving and snapping. No wear.
bodkin/ perforator tip fragment	1	Middle Archaic	Artiodactyla	metacarpal diaphysis	45	7.5	4	Sharply tapering tip section of long thin tool. Cross section only slightly oval shaped on 2 mm wide tip. Tip has slight tear-out. Tool blank prepared by unknown method. Surfaces and edges ground to final shape, then polished. Bright invasive polish and rounding of high points present with

Form	#	Cultural Context	Taxon	Element	Length (mm)	Width (mm)	Thick-ness (mm)	Comments
								extensive fine smooth-edged transverse striations, consistent with contact from dry hide.
expedient tool, butchering	1	Terminal Late Archaic	Artiodactyla	tibia, disto-lateral diaphysis	96	30	23.5	Proximal fragment or larger tool. Element has been split longitudinally, but this appears to be unintentional. Distal articular surface exhibits remnant of round perforation with radiating grooves. Distal end has discoloration and rounding on portion of edge. Extensive minor carnivore ravaging observed. Old individual with arthritic lipping of articular surface. Blank prepared from helically fractured tibia fragment that was distally scraped to shape, then reshaped by flaking to renew edge. Medium invasive polish present on most high and few low points. Use wear consistent with contact from meat.
expedient tool, butchering	1	Terminal Late Archaic	Artiodactyla	indeterminate long bone	62	15	6	Helically fractured long bone fragment with intentional hard-hammer percussion flaking near midpoint along lateral edge. Medium non-invasive polish and slight rounding of few high points at area of flaking. No striations visible and few osteons visible. Use wear consistent with meat contact.

Form	#	Cultural Context	Taxon	Element	Length (mm)	Width (mm)	Thick-ness (mm)	Comments
expedient tool, butchering	1	Terminal Late Archaic	Artiodactyla	humerus, distal diaphysis	49	22	17	Helically fractured long bone fragment with 22.5 mm long area of intentional bifacial hard-hammer percussion flaking near midpoint along lateral edge. Bright invasive polish and slight rounding of high points of flake scars and adjacent areas. Few osteons visible. Use wear consistent with contact from meat.
expedient tool, butchering	1	Terminal Late Archaic	Artiodactyla	tibia, proximal diaphysis	50	18	6	Utilized helically fractured tibia fragment with utilization along 13 mm long on lateral edge. Item burned, making exact use wear determination difficult. Bright non-invasive polish on external surface of fragment, including distal fracture with visible osteons. Use wear consistent with contact from meat.
expedient tool, butchering, utilized fish scale	1	Historic – Late Prehistoric	*Lepisosteus* sp.	scale, ganoid	18	7	1.5	Proximo-medial segment of utilized scale from a large gar. Bright to medium non-invasive polish present proximally on high points and visible osteons are consistent with use wear from meat.
expedient tool, cutting	1	Late Archaic	Artiodactyla	humerus diaphysis	53	23	14	Expedient tool manufactured from bone tube manufacturing fragment that was helically fractured and then grooved medially and on distal end.

Form	#	Cultural Context	Taxon	Element	Length (mm)	Width (mm)	Thick-ness (mm)	Comments
								Two small areas of unifacial intentional hard-hammer percussion flaking near end of one lateral edge. Medium non-invasive polish and slight rounding of few high points at area of flaking. Few osteons visible with no striations. Use wear consistent with contact from meat.
expedient tool, hide-working	1	Terminal Late Archaic	Artiodactyla	radius diaphysis	115	16.5	7.5	Expedient tool has evidence of implement manufacturing stage of shaping between blank extraction and finishing and possible refitting. Blank removal was by grooving and snapping, then the periosteum was scraped off of the outer surface. Extensive minor pitting is evident. Middle portions of lateral edges were shaped by dynamic fracturing using hard hammer percussion, producing scalloped edge profile. Lateral edge ends are slightly rounded and polished. Weak non-invasive polish on few high points and lateral edges on one end. Scalloped edges show slight polish and rounding. Use wear consistent with contact from hide with hair.
expedient tool, spatulate, bone	1	Middle Archaic	Artiodactyla	tibia, diaphysis	109	16	6	Proximo-lateral portion of larger tool. Fragment weathered and slightly root-etched. Blank produced from helically fractured

Form	#	Cultural Context	Taxon	Element	Length (mm)	Width (mm)	Thick-ness (mm)	Comments
								element, then scraped and ground to final shape. Bright non-invasive polish and rounding present on high points distally. Transverse fine to medium sharp-edged striations present distally, consistent with wear from silica-rich plants.
expedient tool, spatulate, bone	1	Terminal Late Archaic	Carnivora	ulna, proximal epiphysis and diaphysis	105	25	15	Coyote or domestic dog-sized carnivore element with helical fracture and expediently utilized distal fracture. Longitudinal scraping to remove periosteum present medially and distally. Distal fracture and much of ventral surface polished. Use wear is consistent with contact by hide with attached hair.
flesher	1	Terminal Late Archaic	Artiodactyla	rib, distal diaphysis	50	13	4	Medio-distal portion of medium-length tool. Tip is 10 mm wide. Blank prepared by unknown method and then modified by multiple unifacial flakes removed across transverse proximal fracture that forms tool's distal end. Light invasive polish and slight rounding of high points present at distal end. Few smooth edged striations are visible on high points, suggestive of use wear from meat contact.

Form	#	Cultural Context	Taxon	Element	Length (mm)	Width (mm)	Thick-ness (mm)	Comments
needle fragment	1	Terminal Late Archaic	*Canis* sp.	ulna, distal diaphysis	52.5	8	7	Medial segment of needle manufactured from coyote or domestic dog-sized canid ulna. Tool blank prepared by unknown method. Limited scraping to remove periosteum evident. Minimally-invasive medium polish on high points, with osteons visible. Use wear consistent with contact by dry hide.
needle fragment	1	Terminal Late Archaic	Artiodactyla	indeterminate long bone	63	7	3	Medio-distal segment of needle. Blank prepared by unknown method, with subsequent scraping and grinding to final shape. Proximal half of tool exhibits 50+ transverse grooves, including 9 prominent grooves on one face and two on the other. Bright, invasive polish on distal half, with non-invasive polish on proximal high points. Use wear from wet hide contact.
needle fragment	1	Terminal Late Archaic	Artiodactyla	ulna, distal epiphysis and diaphysis	43	7	4	Proximo-medial segment of needle manufactured from artiodactyl ulna that retains portion of distal epiphysis. Tool blank prepared by grooving and snapping with deep cutmarks radiating from remnant of lateral groove. Original external surface longitudinally scraped on distal half. Non-invasive polish on original external surface, with

Form	#	Cultural Context	Taxon	Element	Length (mm)	Width (mm)	Thick-ness (mm)	Comments
								strong transverse striations or shallow grooving on proximal third of tool. Use wear consistent with contact by dry hide.
perforator fragment	1	Terminal Late Archaic	Artiodactyla	indeterminate long bone	46	5	4	Distal segment of long narrow tool with slightly beveled, rounded tip. Cross section of 2 mm wide tip is approximately round. Tip has slight tear-out and discoloration. One lateral edge slightly flattened. Tool blank prepared by unknown method, then scraped, with subsequent grinding to final shape. Bright non-invasive polish and rounding of high points. Distal fine oblique striations, with proximal transverse medium to fine striations, all smooth-edged. Use wear consistent with contact by wood.
perforator	1	Terminal Late Archaic	Artiodactyla	indeterminate long bone	93	7	3	Complete long narrow tool. Cross section of 2 mm wide tip is approximately round. Tip has two bevels. Highly polished over entirety, with numerous transverse cutmarks over upper 25 percent. Many of the cutmarks are broad and deep--possible grooving for haft. Tool blank prepared by grooving and snapping, then scraped, with subsequent grinding or polishing to final shape. Bright invasive polish

Form	#	Cultural Context	Taxon	Element	Length (mm)	Width (mm)	Thick-ness (mm)	Comments
								with oblique fine striations on distal 20 mm , transverse fine striations from 20 to 45 mm from tip. Use wear consistent with contact by dry hide.
perforator fragment	1	Terminal Late Archaic	Artiodactyla	indeterminate long bone	74.5	10	4	Almost complete long narrow tool. Cross section of 2 mm wide tip is approximately round. Tip has slightly rounded profile. Tool blank prepared by unknown method, then ground to final shape. Heavily weathered with little remnant polish. No remaining use wear evident.
perforator fragment	1	Terminal Late Archaic	Artiodactyla	indeterminate long bone	63.5	10	7	Disto-lateral segment of medium width tool with damaged tip. Tip has 2 mm width and round cross section. Fragment longitudinally split by dry state fracture, weathered, and heavily carnivore ravaged. Tool blank prepared by unknown method, scraping and grinding to final shape. No use wear evident.
perforator fragment	1	Terminal Late Archaic	Artiodactyla	indeterminate long bone	77	14	6.5	Tool in good condition, but exhibits weathering cracks and extensive post-depositional surface pitting. Extreme tip crushed, but has only slightly oval cross section. Tip is 2.5 mm wide. Tool blank prepared by chopping, then scraped, with

Form	#	Cultural Context	Taxon	Element	Length (mm)	Width (mm)	Thick-ness (mm)	Comments
								subsequent grinding to final shape. Invasive polish and rounding on distal half, with up to 15 shallow transverse grooves evident on distal lateral edges. Use wear consistent with contact from wet hide.
perforator fragment	1	Terminal Late Archaic	Artiodactyla	indeterminate long bone	79	9	7	Long narrow tool structurally in good shape, but exhibits weathering cracks, delamination, and extensive surface pitting. Remnants of bright polish still evident. Extreme tip crushed. Narrow tip is 2 mm wide and has round cross section. Tool blank prepared by grooving and snapping, then scraped, with subsequent grinding to final shape. Invasive polish and rounding on distal half. Limited transverse striations present on distal third. Use wear consistent with contact from wet hide.
perforator fragment	1	Terminal Late Archaic	Artiodactyla	indeterminate long bone	119	14	8	Long narrow tool has slight root etching and carnivore ravaging of surface. Long, narrow tip is polished, 2 mm wide, and has a rounded cross section and profile. Tool blank prepared by helical fracturing, then longitudinally split, possibly as refitting. Surface scraped, with subsequent grinding to final shape. Bright invasive

Form	#	Cultural Context	Taxon	Element	Length (mm)	Width (mm)	Thick-ness (mm)	Comments
								polish on external surface, with rounding on high points and fine transverse striations on distal half. Use wear consistent with contact from hide with hair.
perforator fragment	1	Terminal Late Archaic	Artiodactyla	metatarsal, distal epiphysis and diaphysis	80	10	6	Proximo-medial portion of long narrow tool that appears to be a refitted broken tool. Reworked area is considerably pitted. Tool blank originally prepared by grooving and snapping, then longitudinally split, possibly as refitting. Surface scraped to shape distal areas and new tip. Medium bright non-invasive polish and rounding of high points, with transverse to oblique fine smooth-edged striations present medially and visible osteons. Use wear consistent with contact from wood.
perforator fragment	1	Terminal Late Archaic	Artiodactyla	indeterminate long bone	38	7	4	Medial portion of narrow tool. Reworked area is considerably pitted. Tool blank prepared by grooving and snapping, then ground to final shape. Tool fragment partially burned, making exact use wear determination difficult. Bright, non-invasive and rounding on high points. Fine sharp-edged transverse and oblique striations visible. Use wear consistent with contact from

Form	#	Cultural Context	Taxon	Element	Length (mm)	Width (mm)	Thick-ness (mm)	Comments
								silica-rich plants.
perforator fragment	1	Terminal Late Archaic	Artiodactyla	indeterminate long bone	59	11	7	Proximal portion of weathered tool. Tool blank prepared by unknown method and scraped to final shape. Tool fragment partially burned, making exact use wear determination difficult. No remnant use wear visible.
perforator tip fragment	1	Terminal Late Archaic	Artiodactyla	metapodial diaphysis	41	6	5	Distal portion of narrow tool. Tip is slightly damaged by tear-out, 2.5 mm wide, and has a rounded cross section and profile. Tool blank prepared by grooving and snapping, then scraped and ground to final shape. Tool fragment partially burned, making exact use wear determination difficult. Bright non-invasive polish with rounding of high points. Fine to medium smooth edged oblique striations visible distally. Use wear consistent with contact from wood.
perforator fragment	1	Middle Archaic	Artiodactyla	metapodial diaphysis	26	5	5	Medio-distal portion of narrow tool. Cross section round throughout. Tool blank prepared by unknown method and scraped to final shape. Bright invasive polish with fine to medium sharp edged oblique to transverse striations present, especially on longitudinal area not

Form	#	Cultural Context	Taxon	Element	Length (mm)	Width (mm)	Thick-ness (mm)	Comments
								scraped. Common micro-pitting. Use wear consistent with contact by sandy dry hide.
perforator fragment	1	Middle Archaic	Artiodactyla	metapodial diaphysis	60	8	5	Medial portion of longer, narrow tool. Tool blank prepared by grooving and snapping, then scraped and ground to final shape. Bright non-invasive polish and rounding present on high points. Fine sharp-edged oblique to transverse striations visible distally are consistent with use wear from contact with silica-rich plants.
perforator fragment	1	Late Archaic	Osteichthyes	dorsal spine	23	3	2	Medio-distal portion of narrow tool. Extreme tip is damaged by dry-state fracture, but distal fracture has rounded cross section. Tool blank prepared by unknown method. Bright non-invasive polish with rounding of high points. Use wear consistent with contact from silica-rich plants.
perforator, catfish spine fragment	1	Terminal Late Archaic	*Ictalurus furcatus*	pectoral spine	49	5	3	Distal portion of narrow tool. Tip has 1.25 mm width, small tear-out and micro-bevels, and a flattened oval cross-section from original shape of element. Tool fragment has desiccation cracks. Tool blank modified by distal grinding to shape. Relatively bright, invasive polish on spine and follows surface

Form	#	Cultural Context	Taxon	Element	Length (mm)	Width (mm)	Thick-ness (mm)	Comments
								contours. Striations are small, smooth and rounded. Oblique striations present on distal half of tool. Use wear consistent with contact from dry hide.
preform, fish hook	1	Middle Archaic	Mammalia	indeterminate long bone	17	8.5	3	Latero-proximal segment of possible preform for a bone fish hook. Item is similar in construction to distally notched spatulates and may be related. It exhibits a 10 mm long bifurcation incised and scraped along its mid-point, with remnant of 3.5 mm long tip present. Item longitudinally split adjacent to incised and scraped bifurcation. Fragment burned, making use wear determination conjectural.
pressure flaking tool tip fragment, bone	1	Historic – Late Prehistoric	Artiodactyla	indeterminate long bone	33.5	8	5	Rounded, tapered tip on long narrow tool fragment with very slightly root-etching. Tip cross section approximately round, with tip width 2.5 mm. Tip exhibits slight crushing damage and tear-out along one side that also exhibits prominent longitudinal scrapes and striations. Tool blank prepared by unknown method, followed by longitudinal scraping, grinding, and polishing to final shape. Tool fragment partially burned, making

Form	#	Cultural Context	Taxon	Element	Length (mm)	Width (mm)	Thick-ness (mm)	Comments
								exact use wear determination difficult. Bright invasive polish and rounding. Fine widespread sharp-edged v-shaped transverse striations on lateral edges and outer surface of proximal half. Use wear consistent with contact by siliceous stone, wet hide, and silica-rich plant materials.
pressure flaking tool tip fragment, bone	1	Terminal Late Archaic	Artiodactyla	indeterminate long bone	21	5	3.5	Rounded, slightly beveled tip on fragment of long narrow tool. Tip cross section approximately round, with tip width 3 mm. Item appears to have been fragmented from longitudinally split tip of longer tool. Proximal fracture is dry state. Lateral edge has oblique coarse striations originating from tip. Tool blank prepared by unknown method, followed by grinding and polishing to final shape. Bright invasive polish and rounding. Use wear consistent with contact by siliceous stone.
rib tool fragment	1	Historic – Late Prehistoric	Artiodactyla	indeterminate long bone	22.5	5	3	Latero-distal portion of larger tool with beveled, longitudinally split tip. Tip has wide taper on short tool segment and is 2 mm wide. Blank prepared by unknown method, followed by scraping to final shape. Bright non-invasive polish on high points with pitting and transverse

Form	#	Cultural Context	Taxon	Element	Length (mm)	Width (mm)	Thick-ness (mm)	Comments
								deep coarse cutmarks distally. Use wear consistent with contact from wood.
rib tool fragment	1	Terminal Late Archaic	Artiodactyla	rib, distal diaphysis	32	6	4	Latero-distal segment of tool. Blank prepared by grooving and snapping, followed by scraping to final shape. Bright non-invasive polish and slight rounding on high points. No striations visible. Use wear consistent with contact from wood.
spatulate	1	Historic – Late Prehistoric	Artiodactyla	metatarsal, proximal epiphysis and diaphysis	115	22	6	Wide tool with evidence of tip refitting in the form of transverse grooving and snapping 3 mm proximal to distal terminal fracture. Tip section 6 mm wide at this point with oval cross section. Blank prepared by grooving and snapping, followed by scraping and grinding to final shape. Weathering damage and carnivore ravaging removed identifiable use wear.
spatulate	1	Terminal Late Archaic	Artiodactyla	metatarsal, partial proximal epiphysis and diaphysis	153	22	7	Complete, long narrow tool in relatively good condition, but exhibits slight weathering and root etching. Tip section relatively constricted with oval cross section about 3 mm wide, with tip having rounded profile and minor tear-out. Blank prepared by grooving and snapping, followed by scraping and

Form	#	Cultural Context	Taxon	Element	Length (mm)	Width (mm)	Thick-ness (mm)	Comments
								grinding to final shape. Transverse striations on distal half are suggestive of contact by silica-rich plants.
spatulate	1	Terminal Late Archaic	Artiodactyla	humerus diaphysis	74	17	13	Complete, wide, medium length tool with narrow, irregular tip. The tip section is 3 mm wide and has an oval cross section. Tool blank prepared by utilizing helically fractured butchering waste, followed by scraping to final shape. Medium to bright non-invasive polish and rounding of high points, especially ate tip. Smooth fine transverse striations visible medially, with osteons visible at tip. Use wear consistent with contact by wood.
spatulate	1	Terminal Late Archaic	Artiodactyla	metatarsal diaphysis	116	14	6	Long narrow tool with gently taped distal section. Tip is 2.5 mm wide and slightly rounded and beveled. Tool blank prepared by helical fracturing, followed by distal scraping and grinding to final shape. Bright non-invasive polish is present on high points, with rounding on distal half. Fine to medium oblique to transverse smooth-edged striations visible distally. Use wear consistent with contact from wood.

Form	#	Cultural Context	Taxon	Element	Length (mm)	Width (mm)	Thick-ness (mm)	Comments
spatulate	1	Late Archaic	Artiodactyla	metatarsal, proximal epiphysis and diaphysis	164	25	8.5	Almost complete long relatively wide tool, missing small portion of one lateral edge and extreme tip. Cross section of sharp, tapering tip section at distal dry state fracture is oval and 3 mm wide. Blank prepared by unknown method, followed by scraping and grinding to final shape. Bright non-invasive polish and rounding of high points are present, with 7 shallow transverse grooves observed on medial lateral edge. Fine sharp transverse striations also present medio-distally. Use wear is consistent with contact by silica-rich plants.
spatulate fragment	1	Terminal Late Archaic	*Aplodinotus grunniens*	dorsal spine	56	11.5	10	Proximo-medial portion of larger tool manufactured from large freshwater drum. Tool blank prepared by unknown method, followed by distal scraping to final shape. Bright invasive polish present on distal third of specimen. Oblique, smooth-edged, rounded striations visible on distal lateral edges and are consistent with wear from wet hide.
spatulate fragment	1	Historic – Late	Artiodactyla	indeterminate long bone	53.5	12	5	Medio-distal segment of tool from position where relatively narrow distal section makes transition to

Form	#	Cultural Context	Taxon	Element	Length (mm)	Width (mm)	Thick-ness (mm)	Comments
		Prehistoric						wider shallow U-shaped medial cross section. Highly polished tool fragment in excellent condition and slightly "smoked" (lightly burned), making exact use wear determination difficult. Minor carnivore ravaging evident. Proximal and distal fractures are dry-state. Tool blank prepared by unknown method, followed by scraping and grinding to final shape. Bright, invasive polish on most of surface, especially high points. Fine and moderately coarse transverse and oblique striations on external surfaces. Minor pitting also evident. Use wear consistent with contact from wet hide.
spatulate fragment	1	Historic – Late Prehistoric	Artiodactyla	indeterminate long bone	43.5	13	5	Medio-distal segment of tool from position where relatively narrow distal section makes transition to wider shallow U-shaped medial cross section. Slightly weathered tool fragment with remnant polish in good condition, but has some delamination and minor carnivore ravaging and extensive pitting. Proximal and distal terminal fractures are dry state. Tool blank prepared by unknown method, followed by scraping to final shape. Bright, invasive polish on most of

Form	#	Cultural Context	Taxon	Element	Length (mm)	Width (mm)	Thick-ness (mm)	Comments
								surface, especially high points. Use wear consistent with contact from wet hide.
spatulate distal tip fragment	1	Historic – Late Prehistoric	Artiodactyla	metatarsal, mesial diaphysis	140	18	8	Long, wide tool has narrow tip section. Tip is 3 mm with oval cross section and rounded profile. Tool is heavily etched by weathering and exhibits significant rodent gnawing. It exhibits a remnant unidentified polish over much of the un-etched surface. Tool blank prepared by unknown method, followed by grinding to final shape.
spatulate fragment	1	Historic – Late Prehistoric	Artiodactyla	metatarsal, mesial diaphysis	102	16	7.5	Proximo-mesial fragment of longitudinally split tool with significant etching and minor carnivore ravaging. It retains both manufacturing and use wear signatures. Blank prepared by grooving and snapping, followed by scraping and grinding to final shape. Remnant bright polish on much of raised surfaces, with transverse scratching and striations evident on portions of lateral surface and outer surface. Use wear consistent with contact from silica-rich plants.

Form	#	Cultural Context	Taxon	Element	Length (mm)	Width (mm)	Thick-ness (mm)	Comments
spatulate fragment	1	Historic – Late Prehistoric	Artiodactyla	metapodial diaphysis	29	13	4.5	Latero-medial segment of tool. Extensive carnivore ravaging is present. Tool blank prepared by unknown method, followed by scraping to final shape. Fragment burned on inner surface, making exact use wear determination difficult. Moderately bright, invasive polish present on inner and outer surfaces, especially high points. No striations are evident. Remnant use wear consistent with contact from wet hide.
spatulate fragment	1	Historic – Late Prehistoric	Artiodactyla	metapodial diaphysis	35	9	5.5	Proximal segment of very weathered and eroded larger tool. Tool blank prepared by unknown method, followed by scraping and distal grinding to final shape. Use wear indeterminate due to heavy weathering damage.
spatulate, distal fragment	1	Historic – Late Prehistoric	Artiodactyla	metapodial diaphysis	66	11	6	Distal portion of moderately weathered larger tool longitudinally fractured while raw material was fresh. Broad sharp tip reworked, with dorso-ventral bevels on left edge. Blank prepared by grooving and snapping, then scraping and grinding to final shape. Bright non-invasive polish and rounding pres-ent on high points. Fine sharp-edged transverse striations on high

Form	#	Cultural Context	Taxon	Element	Length (mm)	Width (mm)	Thick-ness (mm)	Comments
								points and lateral edge. Use wear consistent with silica-rich plant contact.
spatulate, distal fragment	1	Historic – Late Prehistoric	Artiodactyla	metapodial diaphysis	53	15	4.5	Distal portion of moderately weathered and pitted larger tool retains significant areas of polish. Proximal end has wide, flattened U-shaped cross section. Tip section is 3.5 mm wide and oval shaped. Tip profile is slightly rounded and tapered on medium width tool fragment. Blank prepared by grooving and snapping, followed by scraping and grinding to final shape. Bright non-invasive polish and rounding were observed on high points. Four oblique medium width partial wear grooves are present on the lateral edges near tip. Oblique to transverse fine sharp edged striations are visible, consistent with use wear from silica-rich plants.
spatulate, distal fragment	1	Historic – Late Prehistoric	Artiodactyla	indeterminate long bone	34.5	10	4.5	Distal portion of moderately weathered and pitted larger tool has moderate carnivore ravaging. The tip section angled towards one side and slightly beveled to the internal surface of bone fragment. A slight tear out of the tip is visible. The tip has a slightly rounded profiled with

Form	#	Cultural Context	Taxon	Element	Length (mm)	Width (mm)	Thick-ness (mm)	Comments
								a short, abrupt taper on a medium width tool. Cross section of the tip is oval and 3 mm wide. Blank prepared by unknown method, then scraped to final shape. Bright non-invasive polish and slight rounding on high points. No striations are visible. Use wear is consistent with contact by hide with hair.
spatulate, fragment	1	Historic – Late Prehistoric	Artiodactyla	metapodial diaphysis	33	9	4.5	Medio-distal portion of larger tool's lateral edge. Fragment is heavily carnivore-ravaged and slightly root-etched, but still retains excellent use wear polish. Blank prepared by unknown method, then distally and medially ground to final shape. Continuous bright polish is evident on raised edge and portions of outer surface. Frequent oblique and transverse smooth-edged striations are present, consistent with use wear from dry hide.
spatulate fragment	1	Terminal Late Archaic	Artiodactyla	indeterminate long bone	60	12.5	5.5	Nearly complete medium length, relatively narrow tool with slight carnivore ravaging. Tip is damaged by dry-state fracture, but one side is virtually intact and shows evidence of dorso-ventral beveling. At 4 mm from tip, cross section is just slightly oval and 2.5 mm wide. Proximal blank preparation appears

Form	#	Cultural Context	Taxon	Element	Length (mm)	Width (mm)	Thick-ness (mm)	Comments
								to use a helical fracture, with distal scraping further shaping tool. Bright non-invasive polish and slight rounding of high points suggestive of use wear from wood contact.
spatulate fragment	1	Terminal Late Archaic	Artiodactyla	metapodial diaphysis	50	10	3	Disto-lateral fragment of larger tool that is weathered and delaminating proximally, with a longitudinal desiccation crack visible. Tip is damaged, with about 3 – 4 mm missing. Tip width taken at terminal fracture is 2 mm and tip has an oval cross section with a narrow, gently tapering profile. Blank prepared by unknown method, then grinding to final shape. Bright non-invasive polish and rounding present on high points. Transverse shallow use wear grooves on right lateral edge on upper surface. Fine sharp-edged distal oblique striations and transverse proximally are consistent with use wear from contact by silica-rich plants.
spatulate fragment	1	Terminal Late Archaic	Artiodactyla	metacarpal diaphysis	66	14	9	Two conjoining fragments form distal portion of larger tool. The cross-section at the remaining distal fracture is oval in shape. Blank prepared by chopping, then scraping and grinding to final shape. Bright

Form	#	Cultural Context	Taxon	Element	Length (mm)	Width (mm)	Thick-ness (mm)	Comments
								polish present in some areas, with some rounding on high points. Fine to medium transverse striations with smooth rounded edges visible on polished areas, consistent with wear by contact with wood.
spatulate fragment	1	Terminal Late Archaic	Artiodactyla	indeterminate long bone	35	12	6	Medial fragment of tool that is possible refitting of wider tool longitudinally during use. One lateral edge smoothed and highly polished, the other is rougher and scraped. Blank prepared by grooving and snapping, followed by scraping and grinding to final shape. Bright non-invasive polish and rounding of high points. Fine sharp edged transverse striations on left dorsal lateral edge. Use wear consistent with contact by silica-rich plants.
spatulate distal tip fragment	1	Terminal Late Archaic	Artiodactyla	metapodial diaphysis	82	14	5	Distal portion of long, moderately wide tool with tapering, relatively constricted tip section. Tip has oval cross section, is 2.5 mm wide, and has slight tear-out damage from use. Blank prepared by grooving and snapping, followed by scraping and grinding to final shape. Bright invasive polish and rounding on high points. Wide shallow and fine oblique transverse striations visible

Form	#	Cultural Context	Taxon	Element	Length (mm)	Width (mm)	Thick-ness (mm)	Comments
								on lateral edges and ventral aspects. Tip tear out has polish. Use wear consistent with contact by wood.
spatulate fragment	1	Terminal Late Archaic	Artiodactyla	metatarsal diaphysis	55	7	6.5	Disto-lateral fragment of longitudinally split tool. Blank prepared by grooving and snapping, followed by scraping and grinding to final shape. Bright non-invasive polish and rounding on high points. Oblique fine striations near tip, with transverse striations proximally. Striations are smooth edged and consistent with use wear from contact by wood.
spatulate distal tip fragment	1	Terminal Late Archaic	Artiodactyla	metapodial diaphysis	31	8	3.5	Moderately tapering tip section of short section of refitted tool. Tip has oval cross section, has tear out damage, and is 3 mm wide. One lateral edge appears to be worn from reuse of longitudinally broken tool. Tool blank prepared by unknown method, followed by scraping and grinding to final shape. Bright non-invasive polish and rounding on high points. Fine sharp-edged transverse striations present on lateral edges proximally, oblique striations present distally. Use wear consistent with contact by silica-rich plants.

Form	#	Cultural Context	Taxon	Element	Length (mm)	Width (mm)	Thick-ness (mm)	Comments
spatulate fragment	1	Terminal Late Archaic	Artiodactyla	metapodial diaphysis	33	5.5	5.5	Disto-lateral fragment of burned tool. Tool blank prepared by unknown method, followed by scraping and grinding to final shape. Burning makes exact use wear determination difficult, but bright non-invasive polish and rounding on high points is consistent with contact by silica-rich plants.
spatulate fragment	1	Terminal Late Archaic	Artiodactyla	metapodial diaphysis	59	15	6	Distal portion of short, wide tool, with proximal groove and snap fracture. Dry state fracture removed missing tip. Tool blank prepared by unknown method, followed by scraping and grinding to final shape. Bright non-invasive polish and rounding on high points. Fine to medium sharp-edged transverse striations on high points. Use wear consistent with contact by silica-rich plants.

Form	#	Cultural Context	Taxon	Element	Length (mm)	Width (mm)	Thick-ness (mm)	Comments
spatulate fragment	1	Terminal Late Archaic	Artiodactyla	indeterminate long bone	24.5	14	5	Distal portion of tool. Blank prepared by grooving and snapping, followed by scraping and grinding to final shape. Fragment burned, making exact use wear determination difficult. Bright non-invasive polish and rounding of high points. Fine to medium, sharp-edged, transverse to oblique striations on high points. Use wear consistent with contact by silica-rich plants.
spatulate fragment	1	Terminal Late Archaic	Artiodactyla	metatarsal diaphysis	36.5	13	8	Medial portion of tool manufactured from quartered metatarsal. Blank prepared by grooving and snapping, followed by scraping and distal grinding to final shape. Bright invasive polish is consistent with dry hide contact use wear.
spatulate fragment	1	Terminal Late Archaic	Artiodactyla	metapodial diaphysis	45	5	4.5	Small proximal fragment of tool that retains evidence of blank preparation and detachment from articulation. Blank prepared by longitudinal and transverse grooving and snapping, followed by scraping to final shape. Bright non-invasive polish and rounding of high points, especially at proximal end. Few sharp-edged fine oblique striations distally. Use wear con-

Form	#	Cultural Context	Taxon	Element	Length (mm)	Width (mm)	Thick-ness (mm)	Comments
								sistent with contact by silica-rich plants.
spatulate distal tip fragment	1	Terminal Late Archaic	Artiodactyla	metapodial diaphysis	31	6	3.5	Distal portion of gently tapered tool with longitudinal desiccation crack and carnivore ravaging. Rounded and beveled tip has oval cross section and is 3 mm wide. Blank prepared by unknown method, followed by scraping and grinding to final shape. Bright non-invasive polish and rounding present. Oblique fine striations distally, transverse fine to medium proximally, all sharp-edged. Use wear consistent with contact by silica-rich plants.
spatulate fragment	1	Terminal Late Archaic	Artiodactyla	metapodial diaphysis	38	14	5	Latero-distal portion of tool. Blank prepared by unknown method, followed by scraping and grinding to final shape. Fragment burned, making exact use wear determination difficult. Grouped transverse striations on lateral edge. Use wear consistent with contact by silica-rich plants.
spatulate distal tip fragment	1	Terminal Late Archaic	Artiodactyla	indeterminate long bone	35	5	4.5	Latero-distal portion of tool with intact tip and longitudinal and proximal dry state fractures. Cross section of medium width slightly beveled tip section is oval and 3

Form	#	Cultural Context	Taxon	Element	Length (mm)	Width (mm)	Thick-ness (mm)	Comments
								mm wide at tip. Prominent tip tear-out noted. Blank prepared by unknown method, followed by scraping to final shape. Bright non-invasive polish and rounding on high points. Pitting common, with transverse smooth fine striations on smoother high points. Use wear consistent with contact from wood.
spatulate fragment	1	Terminal Late Archaic	Artiodactyla	indeterminate long bone	65	11	4	Latero-distal edge of tool with slight root etching and weathering damage. Blank prepared by unknown method, followed by scraping and distal grinding to final shape. Non-invasive polish is present on surface high points, especially distally, with transverse fine striations also visible laterally on distal half. Use wear consistent with contact by silica-rich plants.
spatulate fragment	1	Terminal Late Archaic	Artiodactyla	indeterminate long bone	61	10	5	Latero-distal edge of tool with slight weathering crack damage on external surface. Blank prepared from probably metapodial by unknown method, followed by scraping and grinding to final shape. Non-invasive polish is present on surface high points, especially distally, with transverse fine striations and shallow use wear grooving also visible laterally on

Form	#	Cultural Context	Taxon	Element	Length (mm)	Width (mm)	Thick-ness (mm)	Comments
								distal half. Use wear consistent with contact by silica-rich plants.
spatulate distal tip fragment	1	Terminal Late Archaic	Artiodactyla	metacarpal diaphysis	132	17	6.5	Nearly complete, long, narrow tool with constricted tip beveled laterally. Surface is pitted and weathered, but retains evidence of manufacture and large areas of polish. Tip is 3 mm wide, has oval cross section, and lateral tear-out. Remnant proximal transverse groove and snap fracture removed articulation. Blank prepared by grooving and snapping, followed by scraping and distal grinding to final shape, including interior surface of bone. Non-invasive polish present on much of surface. Transverse fine striations present medially. Discoloration near tip on inner surface. Use wear consistent with contact by silica-rich plants.
spatulate fragment	1	Terminal Late Archaic	Artiodactyla	metapodial diaphysis	42	10	3.5	Distal segment of tool. Blank prepared by unknown method, followed by scraping and grinding to final shape. Fragment burned, making exact use wear determination difficult. Bright invasive polish with rounding of high points and very common fine transverse striations with smooth,

Form	#	Cultural Context	Taxon	Element	Length (mm)	Width (mm)	Thick-ness (mm)	Comments
								rounded edges. Use wear consistent with contact from dry hide.
spatulate fragment	1	Terminal Late Archaic	Artiodactyla	metapodial diaphysis	19	7	4	Small lateral segment of much larger tool. Blank prepared by grooving and snapping, followed by scraping to final shape. Medium non-invasive polish and rounding on high points. Oblique smooth--edged striations visible distally. Osteons are visible. Use wear consistent with that produced by wood.
spatulate fragment	1	Terminal Late Archaic	Artiodactyla	metatarsal diaphysis	51.5	7	6	Disto-lateral portion of larger tool. Blank prepared by grooving and snapping, followed by scraping and grinding to final shape. Bright non-invasive polish and rounding on high points. More than 10 shallow medium grooves present on lateral edge. Fine sharp-edged transverse striations are present distally. Use wear consistent with contact by silica-rich plants.
spatulate fragment	1	Terminal Late Archaic	Artiodactyla	metatarsal diaphysis	29	16	4	Medial segment of larger tool. Fragment exhibits flattened cross section. Blank prepared by grooving and snapping, followed by scraping and grinding to final shape. Tool fragment burned, making exact use wear determination difficult. Bright

Form	#	Cultural Context	Taxon	Element	Length (mm)	Width (mm)	Thick-ness (mm)	Comments
								non-invasive polish and rounding of high points present. Two medium transverse grooves in one lateral edge, with fine to medium transverse grooves on lateral edges and high points. Use wear con-sistent with contact by silica-rich plants.
spatulate fragment	1	Terminal Late Archaic	Artiodactyla	metatarsal diaphysis	75	15	5.5	Proximal segment of larger tool. Blank prepared by grooving and snapping, followed by scraping and grinding to final shape. Tool fragment burned, making exact use wear determination difficult. Bright non-invasive polish and rounding on high points. Fine to medium transverse striations on lateral edges and high points. Use wear con-sistent with contact by silica-rich plants.
spatulate fragment	1	Terminal Late Archaic	Artiodactyla	indeterminate long bone	56	10	5	Lateral fragment of a larger tool. Blank prepared by grooving and snapping, followed by scraping and grinding to final shape. Bright non-invasive polish and slight rounding of high points present. Fine and medium transverse striations are visible on lateral edge, with oblique striations on inner surface. Use wear consistent with contact by silica-rich plants.

Form	#	Cultural Context	Taxon	Element	Length (mm)	Width (mm)	Thick-ness (mm)	Comments
spatulate fragment	1	Terminal Late Archaic	Artiodactyla	metatarsal diaphysis	135	21	11	Almost complete long wide tool with constricted tapering tip section, missing extreme tip. Cross section of tip section at distal terminal fracture is oval with 5.5 mm width. Blank prepared by grooving and snapping, followed by scraping and grinding to final shape. Non-invasive polish present on external, lateral, and high points of inner surface, with many transverse and fewer longitudinal fine striations visible on distal half. Use wear consistent with contact by silica-rich plants.
spatulate fragment	1	Terminal Late Archaic	Artiodactyla	metapodial diaphysis	42	13	6	Weathered medial segment of tool with extensive dry-state, post-depositional fracturing. Only a small area of lateral edge present on fragment. Blank prepared by unknown method, followed by longitudinal scraping and grinding to final shape. Non-invasive polish on lateral and outer surfaces and extensive transverse striations are consistent with use wear from contact with silica-rich plants.
spatulate fragment	1	Terminal Late	Artiodactyla	tibia distal diaphysis	59	34	20	Proximal fragment of heavily weathered tool fragment with remnant polish on distal end of one

Form	#	Cultural Context	Taxon	Element	Length (mm)	Width (mm)	Thick-ness (mm)	Comments
		Archaic						side. Blank prepared by helical fracturing with no apparent further modification. Bright, invasive polish with rounding of high points is present on one side of distal end. Distally, very shallow transverse striations with smooth, rounded edges are present. Use wear is consistent with contact from wet hide.
spatulate fragment	1	Terminal Late Archaic	Artiodactyla	metatarsal diaphysis	35	8	7	Proximo-lateral fragment of longitudinally-split tool segment. Blank prepared by unknown method and scraped to final shape. Bright non-invasive polish and rounding present on high points. Fine sharp-edged transverse striations also visible on high points are consistent with use wear from contact with silica-rich plants.
spatulate fragment	1	Terminal Late Archaic	Artiodactyla	metatarsal diaphysis	172	19	9	Almost complete long, narrow tool with beveled, constricted tip section. Cross section of tip section is ovate and 3 mm wide. Tool weathered, cracked, and has minor carnivore ravaging, but is in relatively good condition with nearly all polish, striations, and longitudinal scratching remaining on tool surfaces. Blank prepared by chopping, then scraped and ground

Form	#	Cultural Context	Taxon	Element	Length (mm)	Width (mm)	Thick-ness (mm)	Comments
								to final shape. Bright, non-invasive polish present on high points. Fine transverse parallel striations noted near edges, with similar striations obliquely-oriented on the distal outer face of middle half. Use wear is consistent with use wear from contact with silica-rich plants.
spatulate fragment	1	Terminal Late Archaic	Artiodactyla	metatarsal diaphysis	129	25	12.5	Proximo-medial segment of longer tool, with tip absent. Tool fragment is weathered and carnivore-ravaged. More than fifteen oblique cutmarks are present on external surface and a deep transverse cutmark occurs on the proximal external surface. Blank prepared by grooving and snapping, followed by scraping and grinding to final shape. Remnants of non-invasive polish present over much of surface. Fine transverse striations are also present on distal half. Use wear is consistent with use wear from contact with silica-rich plants.
spatulate fragment	1	Terminal Late Archaic	Artiodactyla	indeterminate long bone	31.5	12	7	Medial fragment of a larger tool. Blank prepared by grooving and snapping, followed by scraping and distal grinding to final shape. Fragment slightly burned, making use wear determination difficult. No apparent use wear polish noted.

Form	#	Cultural Context	Taxon	Element	Length (mm)	Width (mm)	Thick-ness (mm)	Comments
spatulate fragment	1	Terminal Late Archaic	Artiodactyla	metapodial diaphysis	42	4	4.5	Latero-distal fragment of larger tool. Blank prepared by unknown method and scraping to final shape. Bright non-invasive polish and rounding of high points are present. Fine sharp-edged transverse striations are also present on dorsal and ventral aspects. Use wear is consistent with contact from silica-rich plants.
spatulate fragment	1	Terminal Late Archaic	Artiodactyla	metapodial diaphysis	21	7	4	Small latero-distal fragment of larger tool. Remaining lateral edge exhibits irregular edge with ripples. Blank prepared by grooving and snapping, followed by scraping to final shape. Bright non-invasive polish and rounding on high points. Few striations visible. Use wear consistent with contact from wood.
spatulate fragment	1	Terminal Late Archaic	Artiodactyla	metatarsal, proximal epiphysis and diaphysis	125	27	16	Almost complete short wide tool with tapering, constricted distal section. Although extreme section of tip is missing width at the terminal fracture is 5 mm and its cross section is ovate. Proximal section of tool is very weathered, with the remainder of the tool's surface less so. Blank prepared by grooving and snapping, followed by grinding to final shape. Nine shallow grooves found worn into

Form	#	Cultural Context	Taxon	Element	Length (mm)	Width (mm)	Thick-ness (mm)	Comments
								mid-section of lateral edge, with a single similar groove found on opposite edge just distal to this point. Non-invasive polish found on high points, with fine striations laterally. Area of grooving has invasive polish, discoloration, and rounding. Use wear is consistent with two uses, general contact by silica-rich plants and wet hide in areas of grooving.
spatulate fragment	1	Terminal Late Archaic	Artiodactyla	indeterminate long bone	91	15	5	Medio-distal portion of long narrow, multi-purpose tool with constricted, beveled tip. Cross section of tip is ovate and 3.5 mm wide and tip exhibits bevel and tear-out damage. Proximal end removed by post-deposition dry-state compression fracture. Tool fragment has limited carnivore ravaging, but is in otherwise good condition. Blank prepared by grooving and snapping, followed by grinding to final shape. One lateral edge exhibits broad lunate notch with associated numerous transverse smaller grooves and striations. Non-invasive polish on high points, including internal surface. Portions of internal surface and notch area discolored, with brighter polish. Significant

Form	#	Cultural Context	Taxon	Element	Length (mm)	Width (mm)	Thick-ness (mm)	Comments
								transverse striations & rounding at notch. Non-invasive polish and bevel consistent with contact by silica-rich plants. Notch area discoloration, striations, brighter polish, and rounding are consistent with use wear from sinew and wet hide.
spatulate fragment	1	Terminal Late Archaic	Artiodactyla	metapodial diaphysis	31	12	5	Medio-lateral portion of larger tool. Blank prepared by grooving and snapping, followed by scraping to final shape. Fragment is burned, making exact use wear determination difficult. No apparent use wear polish evident.
spatulate fragment	1	Terminal Late Archaic	Artiodactyla	metapodial diaphysis	59	13	5	Mesio-distal portion of larger tool that has extreme tip missing, but evidence of sharp taper to narrow tip section. Blank prepared by unknown method and ground to final shape. Medial portion of tool burned. Very bright polish with rounding of high points present. Fine transverse striations are evident on high points, lateral edges, and ventral aspect. Use wear consistent with contact by dry hide.

Form	#	Cultural Context	Taxon	Element	Length (mm)	Width (mm)	Thick-ness (mm)	Comments
spatulate fragment	1	Terminal Late Archaic	Artiodactyla	metatarsal, proximal diaphysis	42	9.5	7	Proximal segment of heavily weathered tools Surface weathered and pitted. Blank prepared by grooving and snapping, followed by scraping and grinding to final shape. Bright non-invasive polish and rounding of high points are consistent with contact by silica-rich plants.
spatulate fragment	1	Terminal Late Archaic	Artiodactyla	metapodial diaphysis	34	11	5	Medio-distal portion of larger tool. Blank prepared by grooving and snapping, followed by scraping and grinding to final shape. Bright non-invasive polish and rounding present on high points. Fine to medium smooth-edged striations are also visible on high points. Use wear is consistent with contact from wood.
spatulate fragment	1	Terminal Late Archaic	Artiodactyla	indeterminate long bone	52	13	5	Medio-distal portion of larger tool. Blank prepared by unknown method, then scraped and ground to final shape. Specimen burned, making exact use wear determination difficult. Bright, non-invasive polish and surface rounding present on high points. Transverse fine striations present on high points. Use wear is consistent with contact by silica-rich plants.

Form	#	Cultural Context	Taxon	Element	Length (mm)	Width (mm)	Thick-ness (mm)	Comments
spatulate fragment	1	Terminal Late Archaic	Artiodactyla	indeterminate long bone	44	5.5	5.5	Lateral fragment of larger tool that is significantly weathered with lateral and distal dry state fractures and multiple longitudinal desiccation cracks. Blank prepared by unknown method, then scraped and ground to final shape. Bright non-invasive polish is present on high points with rounding of edges. Fine, transverse striations with sharp, v-shaped edges are very common on lateral edges and high points. Use wear is consistent with contact by silica-rich plants.
spatulate fragment	1	Terminal Late Archaic	Artiodactyla	indeterminate long bone	49	7	5.5	Latero-distal fragment of larger tool that is significantly weathered with lateral and distal dry state fractures and two longitudinal desiccation cracks. Blank prepared by grooving and snapping, followed by scraping and grinding to final shape. Bright non- invasive polish on high points with rounding of edges. Very common fine, sharp-edged, V-shaped transverse striations on high points and lateral edges. Use wear is consistent with contact by silica-rich plants.

Form	#	Cultural Context	Taxon	Element	Length (mm)	Width (mm)	Thick-ness (mm)	Comments
spatulate fragment	1	Terminal Late Archaic	Artiodactyla	metatarsal, proximal epiphysis and diaphysis	41	23.5	14	Proximal segment of wide, larger tool manufactured from a metatarsal split longitudinally in a cranial to caudal plane. Blank prepared by grooving and snapping, followed by scraping to final shape. Bright invasive polish is present with rounding of raised edges. Micro-pitting is common distally. Use wear is consistent with contact from dry hide.
spatulate fragment	1	Terminal Late Archaic	Artiodactyla	metapodial diaphysis	92	11	5	Medio-distal fragment of larger tool that is weathered and extensively pitted. larger tool that is partially burned on external aspect. Blank prepared by grooving and snapping, followed by scraping and grinding to final shape. Bright non-invasive polish and rounding on high points. Fine sharp edged transverse striations on high points. Use wear is consistent with contact by silica-rich plants.
spatulate fragment	1	Terminal Late Archaic	Artiodactyla	metapodial diaphysis	65	16	5	Medio-distal fragment of larger tool that was reconstructed from 3 conjoining fragments. Blank prepared by unknown method, followed by scraping and grinding to final shape. Bright non-invasive polish and rounding on high points. Medium and fine smooth edged

Form	#	Cultural Context	Taxon	Element	Length (mm)	Width (mm)	Thick-ness (mm)	Comments
								transverse striations on lateral edges. Use wear is consistent with contact by silica-rich plants and wood.
spatulate fragment	1	Terminal Late Archaic	Artiodactyla	metatarsal, proximal diaphysis	41	12	6	Disto-lateral fragment of larger tool that was reconstructed from 2 conjoining fragments. Blank prepared by unknown method, followed by scraping and grinding to final shape. No use wear remains.
spatulate fragment	1	Terminal Late Archaic	Artiodactyla	indeterminate long bone	68	6.5	4	Medial fragment of larger tool that is now missing portion reattached in field repair by excavators. Blank prepared by unknown method, followed by scraping to final shape. Fragment burned, making exact use wear determination difficult. Bright non-invasive polish and rounding on high points. Fine sharp-edged transverse striations on high points. Use wear is consistent with contact by silica-rich plants.
spatulate fragment	1	Terminal Late Archaic	Artiodactyla	metapodial diaphysis	62	7.5	5	Latero-distal portion of larger, weathered tool fragment with multiple desiccation crack, one of which splits fragment longitudinally. Fragment retains much of broad U-shaped proximal cross section and is missing only distal 1 – 2 mm of tip. Tip section

Form	#	Cultural Context	Taxon	Element	Length (mm)	Width (mm)	Thick-ness (mm)	Comments
								profile is sharp, with a sharp taper and has a rounded bevel on the original internal surface of the element. The cross section of the tip section is oval and 2 mm wide at the distal fracture. Blank prepared by grooving and snapping, followed by scraping and grinding to final shape. Bright non-invasive polish and rounding of high points. Tip has slight burning and pronounced rounding on internal surface. Fine smooth edged transverse striations on high points. Use wear is consistent with wood contact.
spatulate fragment	1	Terminal Late Archaic	Artiodactyla	metapodial diaphysis	37	9	4	Latero-distal portion of larger, weathered tool fragment that has been longitudinally split along desiccation crack. Blank prepared by grooving and snapping, followed by scraping to final shape. Bright non-invasive polish and rounding of high points. Fine sharp-edged transverse striations on high points. Use wear is consistent with contact by silica-rich plants.
spatulate, fragment	1	Terminal Late Archaic	Artiodactyla	metapodial diaphysis	49	10	6	Distal fragment removed by dry state fracture in vicinity of tip. This item appears to be a refitting of a larger tool broken by longitudinal fracturing and reshaping. Slight

Form	#	Cultural Context	Taxon	Element	Length (mm)	Width (mm)	Thick-ness (mm)	Comments
								carnivore ravaging, with significant surface etching due to weathering. Blank prepared by grooving and snapping, followed by scraping and grinding to final shape. Medium non-invasive polish and rounding are present on high points. Fine, sharp-edged, transverse striations still visible medially. Use wear is consistent with contact by silica-rich plants.
spatulate fragment	1	Terminal Late Archaic	Artiodactyla	metapodial diaphysis	35	11	5	Distal fragment removed by dry state fracture in vicinity of tip, with extreme tip absent. Blank prepared by unknown method, followed by grinding to final shape. Bright non-invasive polish and rounding present on high points, with sharp-edged oblique fine striations on distal high points and transverse striations medially and proximally. Use wear is consistent with contact by silica-rich plants.
spatulate fragment	1	Terminal Late Archaic	Artiodactyla	metacarpal diaphysis	17.5	6	3	Distal portion of moderately weathered larger tool. Dry-state fracture removed at least 5 mm of distal tip. Proximal boundary is also dry-state fracture. Blank prepared by unknown method, followed by scraping to final shape. Bright non-invasive polish is

Form	#	Cultural Context	Taxon	Element	Length (mm)	Width (mm)	Thick-ness (mm)	Comments
								present, with fine oblique to transverse striations present distally. Striations are smooth-edged, consistent with use wear from wood contact.
spatulate fragment	1	Terminal Late Archaic	Artiodactyla	indeterminate long bone	20	9	4	Distal portion of larger tool, apparently missing about 5 - 10 mm of tip section. Distal terminal fracture has oval cross section. Blank prepared by unknown method. Fragment burned, making exact use wear determination difficult. Medium bright non-invasive polish and rounding are on high points. Medium to fine transverse or oblique striations on lateral edges and dorsal surface are consistent with use wear from contact with silica-rich plants.
spatulate fragment	1	Terminal Late Archaic	Artiodactyla	indeterminate long bone	61	11	6	Distal, highly polished, longitudinally split fragment of larger tool. Distal half of tool fragment is greatly narrowed to long tapering section on otherwise more normally shaped spatulate. Tip relatively sharp with oval cross section 2 mm wide. Tip has slight tear-out. Blank prepared by unknown method, followed by scraping and distal grinding to final shape. Bright non-invasive polish

Form	#	Cultural Context	Taxon	Element	Length (mm)	Width (mm)	Thick-ness (mm)	Comments
								and rounding of high points are present. Fine longitudinal striations visible distally, with trans- verse striations medially at base of tip section and proximally. Striations are all sharp-edged, consistent with use wear from contact with silica-rich plants.
spatulate fragment	1	Terminal Late Archaic	Artiodactyla	metatarsal diaphysis	90	14	6	Distal portion of larger tool with weathering damage and 6 desiccation cracks. Distal 1 mm of tip segment was removed by dry state spall. Narrow tapering tip section with oval cross section on long moderately narrow tool. Tip section width is 3 mm. Blank prepared by grooving and snapping, followed by grinding and polishing to final shape. Bright, non-invasive polish present on high points, with transverse sharp-edged fine striations present on lateral surfaces. Use wear is consistent with contact by silica-rich plants.
spatulate fragment	1	Terminal Late Archaic	Artiodactyla	ulna diaphysis	33	9.5	3.25	Distal portion of larger tool, with damaged tip. Blank prepared by unknown method, followed by scraping and grinding to final shape. Bright, non-invasive polish and rounding of high points is present. Fine transverse to oblique

Form	#	Cultural Context	Taxon	Element	Length (mm)	Width (mm)	Thick-ness (mm)	Comments
								sharp-edged striations observed on proximal half. Use wear is consistent with contact by silica-rich plants.
spatulate fragment	1	Terminal Late Archaic	Artiodactyla	indeterminate long bone	40	9	5	Distal portion of larger tool that appears to be a reuse of fragment that split longitudinally. Proximal end terminates in a dry-state fracture. Distal end is beveled on an angle that roughly corresponds to horizontal plane of original spatulate. Profile of beveled tip is wide with sharp taper on relatively narrow tool. Cross section of tip is oval and 5 mm wide. Blank prepared by unknown method, followed by scraping and grinding to final shape. Medium bright slightly invasive polish with slight rounding of high points is present. High points have very bright polish with grouped narrow smooth-edged striations. Use wear is consistent with that produced by wood.
spatulate fragment	1	Terminal Late Archaic	Artiodactyla	metapodial diaphysis	22	7	4	Distal portion of larger tool, missing estimated 4 mm of tip. Surface has pebbled appearance with wear on high points. Blank prepared by unknown method, followed by grinding to final shape. Medium bright invasive polish

Form	#	Cultural Context	Taxon	Element	Length (mm)	Width (mm)	Thick-ness (mm)	Comments
								present, with rounding of high points. Longitudinal striations are found distally, with oblique transverse striations visible on high points of proximal half. Osteons are visible. Use wear is consistent with that produced by wood.
spatulate fragment	1	Terminal Late Archaic	Artiodactyla	indeterminate long bone	23	10	4.5	Distal portion of larger tool with terminal dry- state fracture, missing estimated 4 mm of tip. Blank prepared by unknown method, followed by scraping and grinding to final shape. Item burned, making exact use wear determination difficult. Micro-pitting common on outer face. Bright polish and surface rounding are present. Very common fine, smooth-edged or rounded transverse striations are present on high points. Use wear consistent with dry hide use.
spatulate fragment	1	Terminal Late Archaic	Artiodactyla	metacarpal, proximal diaphysis	33	11	4.5	Proximal portion of larger tool. Blank prepared by unknown method, followed by scraping and grinding to final shape. Bright non-invasive polish and rounding on high points. Use wear is consistent with contact by silica-rich plants.
spatulate fragment	1	Terminal Late Archaic	Artiodactyla	indeterminate long bone	31.5	9.5	3	Distal portion of larger tool manufactured from thin-walled element. Distal area has flat, wide

Form	#	Cultural Context	Taxon	Element	Length (mm)	Width (mm)	Thick-ness (mm)	Comments
		Archaic						oval cross-section on long narrow tapering tool. Tip profile is 3 mm wide and damaged by small longitudinal spall. Blank prepared by unknown method, followed by scraping and polishing to final shape. Item burned, making exact use wear determination difficult. Medium invasive polish with limited edge rounding is present on high points. Fine sharp transverse striations visible at proximal end on one wide face are consistent with use wear from contact by silica-rich plants.
spatulate fragment	1	Late Archaic	Artiodactyla	metapodial diaphysis	26.5	4.5	3	Latero-distal segment of carnivore ravaged larger tool. Blank prepared by unknown method, followed by scraping and grinding to final shape. Bright non-invasive polish and rounding on high points. Fine to medium transverse sharp-edged striations present on high points, consistent with contact by silica-rich plants.
spatulate fragment	1	Late Archaic	Artiodactyla	metapodial diaphysis	99	8	6	Medio-lateral fragment of larger tool with carnivore ravaging. Blank prepared by grooving and snapping, followed by grinding and polishing to final shape. Bright non-invasive polish and rounding of high points

Form	#	Cultural Context	Taxon	Element	Length (mm)	Width (mm)	Thick-ness (mm)	Comments
								present, with fine, sharp-edged, transverse striations on high points. Use wear consistent with contact by silica-rich plants.
spatulate fragment	1	Late Archaic	Artiodactyla	tibia diaphysis	97	19	9	Almost complete tool based on helically fractured butchering waste. An estimated 3 – 5 mm of tip is absent. Blank prepared from larger bone fragment by medial scraping, followed by medial and distal grinding to final shape. Medium bright non-invasive polish and rounding of high points with fine distal, smooth-edged oblique striations is consistent with use wear from wood contact.
spatulate fragment	1	Late Archaic	Artiodactyla	metapodial diaphysis	85	10	6	Latero-distal fragment of a broad larger tool with battered, rounded tip that appear to have been damaged during use. The fragment is weathered and has multiple longitudinal desiccation cracks. The tapered medium width tip section is 3 mm wide and has an oval cross section. Blank prepared by unknown method, followed by scraping and grinding to final shape. Bright non-invasive polish and rounding are present on high points. Fine sharp-edged transverse striations are also present on high

Form	#	Cultural Context	Taxon	Element	Length (mm)	Width (mm)	Thick-ness (mm)	Comments
								points and consistent with contact by silica-rich plants.
spatulate fragment	1	Late Archaic	Artiodactyla	metapodial diaphysis	26	4.5	3	Latero-distal fragment of a broad larger tool that is carnivore ravaged. Blank prepared by unknown method, followed by scraping and grinding to final shape. Bright non-invasive polish and rounding are visible on high points. Fine to medium transverse sharp-edged striations are present on high points and consistent with contact by silica-rich plants.
spatulate fragment	1	Late Archaic	Artiodactyla	metapodial diaphysis	16	7	4.5	Lateral fragment of larger tool. Blank prepared by unknown method, followed by scraping and grinding to final shape. Fragment burned, making exact use wear determination difficult. Bright non-invasive polish and rounding on high points. Fine oblique striations on high points. Use wear consistent with contact by silica-rich plants.
spatulate fragment	1	Late Archaic	Artiodactyla	metapodial diaphysis	29	14.5	8.5	Proximo-lateral fragment of larger tool. Blank prepared by grooving and snapping, followed by scraping and grinding to final shape. Bright invasive polish and rounding on high points. Fine smooth edged transverse striations visible on high

Form	#	Cultural Context	Taxon	Element	Length (mm)	Width (mm)	Thick-ness (mm)	Comments
								points on lateral edges are consistent with use wear from wood.
spatulate fragment	1	Late Archaic	Artiodactyla	indeterminate long bone	33	5	3.2	Distal portion of relatively narrow weathered tool with desiccation cracking. Tip has oval cross section and is 2 mm wide. Due to presence of glue on proximal terminal fracture, this appears to have been repaired in the field but since become separated. Blank prepared by unknown method, followed by scraping to final shape. Bright, invasive polish is present, especially on high points with very few striations observed. Use wear is consistent with wet hide.
spatulate fragment	1	Late Archaic	Artiodactyla	metatarsal diaphysis	34	13.5	5.5	Lateral portion of larger tool. Blank prepared by unknown method, followed by scraping and grinding to final shape. Bright non-invasive polish and rounding of high points is present. Fine to medium sharp-edged transverse striations are visible on high points. Use wear is consistent with contact by silica-rich plants.
spatulate fragment	1	Late Archaic	Artiodactyla	indeterminate long bone	40	9	3.5	Lateral portion of larger tool. Very little smoothing of surface, possibly early in use life. Blank prepared by grooving and snapping, followed by

Form	#	Cultural Context	Taxon	Element	Length (mm)	Width (mm)	Thick-ness (mm)	Comments
								scraping and grinding to final shape. Item partially burned, making exact use wear determination difficult. Bright non-invasive polish and rounding of high points is present. Use wear is consistent with contact by silica-rich plants.
spatulate fragment	1	Late Archaic	Artiodactyla	metapodial diaphysis	23	10	5	Distal portion of larger tool. Blank prepared by unknown method, followed by scraping and grinding to final shape. Bright non-invasive polish and rounding of high points is present. Fine transverse and oblique striations with sharp edges are visible on high points. Use wear is consistent with contact by silica-rich plants.
spatulate fragment	1	Late Archaic	Artiodactyla	indeterminate long bone	14	9.5	6.5	Distal portion of larger tool. Blank prepared by grooving and snapping, followed by scraping and grinding to final shape. Item partially burned, making exact use wear determination difficult. Bright non-invasive polish and rounding are found on high points. Fine oblique striations with sharp edges are visible. Use wear is consistent with contact by silica-rich plants.

Form	#	Cultural Context	Taxon	Element	Length (mm)	Width (mm)	Thick-ness (mm)	Comments
spatulate fragment	1	Late Archaic	Artiodactyla	metatarsal diaphysis	23	10	5	Latero-distal fragment of larger tool. Blank prepared by unknown method, followed by scraping and grinding to final shape. Bright non-invasive polish and rounding of high points. Fine transverse striations visible proximally on dorsal high point along lateral edge. Use wear is consistent with contact by silica-rich plants.
spatulate fragment	1	Late Archaic	Artiodactyla	indeterminate long bone	51	18	6	Medial segment of larger tool with extensive pitting on original outer surface of element. Blank prepared by grooving and snapping, followed by scraping and grinding to final shape. Bright non-invasive polish and rounding are present on high points. Multiple shallow transverse grooves and extensive sharp edged fine transverse striations visible on lateral edges and ventral surface. Use wear is consistent with contact by silica-rich plants.
spatulate fragment	1	Late Archaic	Artiodactyla	metapodial diaphysis	37	4.5	4	Latero-medial fragment of larger tool. Tool fragment is burned and polished, making exact use wear determination difficult. Blank prepared by unknown method, followed by scraping and grinding to final shape. Bright, invasive polish is present on the unbroken

Form	#	Cultural Context	Taxon	Element	Length (mm)	Width (mm)	Thick-ness (mm)	Comments
								edges of tool. Fine transverse striations with smooth, rounded edges are present on half of the outer edge. Edges of longitudinal scrapes are rounded. Use wear is consistent with dry hide.
spatulate fragment	1	Late Archaic	Artiodactyla	indeterminate long bone	55	6	5	Long fragment of medium to wide tool that includes one lateral edge extending complete length, with the second being present distally. Terminal dry state fracture removed an estimated 5 - 10 mm of distal tip. Cross section at this point is oval. Blank prepared by unknown method, followed by scraping and distal grinding to final shape. Fragment was burned, making exact use wear determination difficult. Bright invasive polish with rounding of high points. Remnants of broad area of deep striations on outer surface at proximal end. Few fine transverse striations scattered on inner surface. Use wear is consistent with contact by silica-rich plants.
spatulate fragment	1	Late Archaic	Artiodactyla	metapodial diaphysis	37	10	5	Latero-distal fragment of pitted larger tool. Blank prepared by grooving and snapping, followed by scraping to final shape. Fragment was burned, making exact use wear

Form	#	Cultural Context	Taxon	Element	Length (mm)	Width (mm)	Thick-ness (mm)	Comments
								determination difficult. Bright non-invasive polish and rounding of high points. Very common fine individual and grouped transverse use wear grooves are present on high points. Individual use wear grooves cross groups obliquely. Use wear is consistent with contact by silica-rich plants.
spatulate fragment	1	Late Archaic	Artiodactyla	indeterminate long bone	27	4	4	Latero-distal fragment of pitted larger tool. Blank prepared by un-known method, followed by scraping to final shape. Fragment was burned, making exact use wear determination difficult. Bright non-invasive polish and rounding of high points present. Very common fine individual transverse grooves observed on high points. Use wear is consistent with contact by silica-rich plants.
spatulate fragment	1	Late Archaic	Artiodactyla	metatarsal, proximal epiphysis and diaphysis	34	12	7.5	Proximo-lateral fragment of tool split longitudinally post-deposition due to weathering, with slight etching and desiccation cracks. Blank prepared by unknown method, followed by scraping and grinding to final shape. Bright non-invasive polish and rounding of high points present, including on proximal end. Few sharp-edged

Form	#	Cultural Context	Taxon	Element	Length (mm)	Width (mm)	Thick-ness (mm)	Comments
								oblique striations were observed on lateral edges. Use wear is consistent with contact by silica-rich plants.
spatulate fragment	1	Terminal Late Archaic to Middle Archaic	Artiodactyla	indeterminate long bone	55	8	5	Stratigraphic context of this specimen is generalized stratum 9 – 19, spanning the end of the Terminal Late Archaic through much of the Middle Archaic sequence in the site. Distal portion of a refitted, longitudinally split larger tool that retains evidence of use on dry hide and silica-rich plants. Tip has rounded, constricted profile, oval cross section, and 2.5 mm width. It shows discoloration and slight tear-out, but no evidence of adjacent transverse striations to indicate rotational use in drilling. Blank prepared by unknown method, followed by scraping and polishing to final shape. Use wear consists of bright polish and transverse striations on original surfaces of spatulate (silica-rich plants), with patchy bright polish and smoothing on high points of longitudinal fracture (dry hide).
spatulate fragment	1	Middle Archaic	Artiodactyla	metapodial diaphysis	32	6.5	6	Latero-distal fragment of larger tool. Blank prepared by unknown method, followed by scraping to final shape. Bright non-invasive

Form	#	Cultural Context	Taxon	Element	Length (mm)	Width (mm)	Thick-ness (mm)	Comments
								polish and rounding present on high points. Fine sharp-edged transverse striations observed on high points. Use wear is consistent with contact by silica-rich plants.
spatulate fragment	1	Middle Archaic	Artiodactyla	metatarsal diaphysis	38	11	11	Proximal segment of larger tool. Blank prepared by grooving and snapping, followed by grinding to final shape. Bright, non-invasive polish and rounding on are present high points. Few fine transverse smooth-edged striations visible on high points. Use wear is consistent with wood.
spatulate fragment	1	Middle Archaic	Artiodactyla	metapodial diaphysis	33	9	6.5	Medio-distal fragment of larger tool. Blank prepared by grooving and snapping, followed by grinding to final shape. Fragment was burned, making exact use wear determination difficult. Bright non-invasive polish and rounding present on high points. Fine transverse and oblique striations observed on lateral edges have sharp edges. Use wear is consistent with contact by silica-rich plants.
spatulate fragment	1	Middle Archaic	Artiodactyla	indeterminate long bone	40	10	6	Tool represents most of relatively short narrow tool that has a proximal groove and snap terminal fracture that may be result of refitting activity. Distal dry-state

Form	#	Cultural Context	Taxon	Element	Length (mm)	Width (mm)	Thick-ness (mm)	Comments
								fracture removed about 5 mm of tip and truncates a small helical fracture with use wear. Pitting is extensive. Blank prepared by grooving and snapping, followed by scraping to final shape. Very bright non-invasive polish and rounding are present on high points, including distal helical fracture. Transverse fine and medium striations are also present. Use wear is consistent with contact by silica-rich plants.
spatulate fragment	1	Middle Archaic	Artiodactyla	metapodial diaphysis	21	8	5	Distal portion of larger tool. Blank prepared by unknown method, followed by grinding to final shape. Bright, non-invasive polish is present on high points, with transecting oblique striations on lateral edges. Use wear is consistent with contact by silica-rich plants.
spatulate fragment	1	Middle Archaic	Artiodactyla	metapodial diaphysis	18	9	5	Proximal segment of larger tool. Specimen burned and exhibits transverse deep intersecting grooves on outer surface. Blank prepared by chopping, followed by scraping and grinding to final shape. Medium non-invasive polish is visible on high points. Fine transverse striations are present distal to grooves on outer surface. Use wear

Form	#	Cultural Context	Taxon	Element	Length (mm)	Width (mm)	Thick-ness (mm)	Comments
								is consistent with contact by silica-rich plants.
spatulate fragment	1	Middle Archaic	Artiodactyla	metatarsal diaphysis	96	14	6	Two conjoining fragments form medio-distal portion of larger tool. Blank prepared by grooving and snapping, followed by scraping and distal grinding to final shape. Bright non-invasive polish and rounding of high points are present. Fine, sharp-edged, oblique striations were observed on distal high points. Use wear is consistent with contact by silica-rich plants.
spatulate fragment	1	Middle Archaic	Artiodactyla	metapodial diaphysis	27.5	7	4	Distal portion of larger tool. Blank prepared by unknown method, followed by scraping and grinding to final shape. Fragment was burned, making exact use wear determination difficult. Bright non-invasive polish and rounding of high points are present. Oblique medium to fine slightly sharp-edged striations were observed on high points with moderate pitting. Use wear is consistent with that produced by wood.
spatulate fragment	1	Middle Archaic	Artiodactyla	metapodial diaphysis	29	6	5	Medio-distal portion of larger tool. Blank prepared by unknown method, followed by scraping and grinding to final shape. Medium

Form	#	Cultural Context	Taxon	Element	Length (mm)	Width (mm)	Thick-ness (mm)	Comments
								non-invasive polish and rounding of high points present. Use wear is consistent with contact by silica-rich plants.
spatulate fragment	1	Middle Archaic	Artiodactyla	tibia diaphysis	51	10	7.5	Distal portion of larger tool. One side of tip section is present and is beveled. Blank prepared by un-known method, with scraping and grinding to final shape. Medium non-invasive polish and rounding of high points present. Medium width longitudinal striations evident on distal bevel, with brighter use wear polish at edges of bevel. Use wear consistent with that produced by wood.
spatulate fragment	1	Middle Archaic	Artiodactyla	metapodial diaphysis	21	6	5	Latero-distal portion of larger tool. Blank prepared by unknown method, with scraping and grinding to final shape. Bright, non-invasive polish and rounding on high points. Fine sharp-edged oblique to trans-verse striations visible on high points. Use wear is consistent with contact by silica-rich plants.

Form	#	Cultural Context	Taxon	Element	Length (mm)	Width (mm)	Thick-ness (mm)	Comments
spatulate fragment	1	Middle Archaic	Artiodactyla	metatarsal, proximal diaphysis	30	6	5	Proximo-lateral tool fragment. Blank prepared by unknown method and scraped to final shape. Medium non-invasive polish on high points suggestive of silica-rich plant use wear.
spatulate fragment	1	Middle Archaic	Artiodactyla	metatarsal, proximal diaphysis	90	17	7	Medio-distal portion of heavily weathered larger tool. Blank prepared by grooving and snapping, with scraping and grinding to final shape. Bright non-invasive polish and rounding of high points. Transverse, sharp-edged, fine and medium striations on lateral edge high points. Use wear consistent with silica-rich plants.
spatulate fragment	1	Middle Archaic	Artiodactyla	metapodial diaphysis	43	7	6	Medial portion of larger tool. Blank prepared by grooving and snapping, with scraping and grinding to final shape. Tool fragment burned, making exact use wear determination difficult. Bright non-invasive polish present, with rounding of high points. Fine smooth-edged transverse striations visible distally. Use wear is consistent with wood.
spatulate fragment	1	Middle Archaic	Artiodactyla	metapodial diaphysis	24	7	5	Lateral portion of larger tool. Blank prepared by grooving and snapping, with scraping to final shape. Bright

Form	#	Cultural Context	Taxon	Element	Length (mm)	Width (mm)	Thick-ness (mm)	Comments
								non-invasive polish and rounding on high points. Use wear consistent with contact by silica-rich plants.
spatulate fragment	1	Middle Archaic	Artiodactyla	metatarsal, proximo-lateral diaphysis	37.5	16	5	Medial segment of larger tool. Blank prepared by unknown method, followed by scraping and grinding to final shape. Bright non-invasive polish and rounding on high points. Fine, sharp edged, transverse striations on high points. Use wear consistent with contact by silica-rich plants.
spatulate fragment	1	Middle Archaic	Artiodactyla	metapodial diaphysis	35	8	5	Medio-lateral fragment of extremely weathered larger tool, with multiple longitudinal desic-cation cracks. Tool fragment has traces of use wear polish. Blank prepared by grooving and snapping, with scraping to final shape. Bright non-invasive polish and rounding on high points. Few transverse fine sharp-edged striations visible on high points. Use wear is consistent with contact by silica-rich plants.
spatulate fragment	1	Middle Archaic	Artiodactyla	metatarsal diaphysis	80	16.5	9	Medio-proximal fragments of larger tool. Two fragments conjoin, but fracture between them appears to have been before deposition. Prox-imal fragment not burned to same degree. Blank prepared by grooving and snapping, with scraping and

Form	#	Cultural Context	Taxon	Element	Length (mm)	Width (mm)	Thick-ness (mm)	Comments
								grinding to final shape. Both fragments are burned, making exact use wear determination difficult. Bright non-invasive polish and rounding are present on high points. Transverse shallow use wear grooving evident on medial and distal lateral edges and outer surface. Fine sharp edged transverse striations are visible in same areas and on inner surface. Use wear is consistent with contact by silica-rich plants.
spatulate fragment	1	Middle Archaic	Artiodactyla	metatarsal, proximal epiphysis and diaphysis	39	17	10	Proximal fragment of larger tool. Blank prepared by grooving and snapping, followed by scraping to final shape. Tool fragment burned, making exact use wear determination difficult. Bright non-invasive polish and rounding is present on medial and distal high points. Use wear is consistent with contact by silica-rich plants.
spatulate fragment	1	Middle Archaic	Artiodactyla	metapodial diaphysis	29	6	5	Latero-distal fragment of larger tool. Blank prepared by unknown method, followed by scraping to final shape. Tool fragment burned, making exact use wear determination difficult. Bright non-invasive polish with rounding of high points is present. Fine, smooth-edged, transverse striations

Form	#	Cultural Context	Taxon	Element	Length (mm)	Width (mm)	Thick-ness (mm)	Comments
								are visible on lateral edge. Use wear is consistent with that produced by sinew.
spatulate fragment	1	Middle Archaic	Artiodactyla	metapodial diaphysis	40	11	8	Medio-distal portion of larger tool that is heavily weathered and delaminating. Tool fragment still retains areas with use wear and manufacturing signatures, including evidence of helical fracture-based blank preparation. Blank further processed by longitudinal scraping to final shape. Medium slightly invasive polish with rounding of high points is present. Fine transverse smooth- to sharp-edged striations observed distally. Use wear is consistent with that produced by wood.
spatulate fragment	1	Middle Archaic	Artiodactyla	metapodial diaphysis	32.5	5	5	Distal portion of heavily weathered larger tool, from immediately proximal to tip. Blank prepared by unknown method, followed by scraping and distal grinding to final shape. Bright non-invasive polish and rounding of high points are present. Fine sharp edged transverse striations are visible on high points. Use wear is consistent with contact by silica-rich plants.

Form	#	Cultural Context	Taxon	Element	Length (mm)	Width (mm)	Thick-ness (mm)	Comments
spatulate fragment	1	No Provenienc e	Artiodactyla	metapodial diaphysis	37	11.5	5.5	Distal portion of moderately weathered larger tool with excellent remaining evidence of helical fracture-based blank preparation. Blank further processed by longitudinal scraping and grinding. Bright invasive polish with rounding of edges. Oblique striations with rounded edges near distal end. Use wear consistent with dry hide contact.
spatulate fragment	1	No Provenienc e	Artiodactyla	metatarsal, proximal diaphysis	66	14	8	Good proximal blank extraction evidence for metatarsal-based spatulate tool. Distal break about 5 - 10 mm from assumed distal tip, oval cross section remains. About 50% of item remains heavily pitted from weathering. Three transverse deep cutmarks adjacent to proximal fracture may represent refitting. Blank prepared by grooving and snapping, followed by longitudinal scraping and grinding to final shape. Bright invasive polish with rounding of high points present. Fine transverse and oblique striations with smooth, rounded edges are visible on lateral edges. Use wear consistent with dry hide contact.

Form	#	Cultural Context	Taxon	Element	Length (mm)	Width (mm)	Thick-ness (mm)	Comments
spatulate fragment	1	No Provenience	Artiodactyla	metapodial diaphysis	50	17	6	Distal portion of larger tool, missing an estimated 5 mm of distal tip. Terminal distal dry state fracture has oval cross section about 5 mm wide. Blank prepared by unknown method, followed by scraping and grinding to final shape. Bright, invasive polish with rounding of high points present. Micro-pitting common, with common transverse, fine, smooth-edged striations on lateral edges. Use wear consistent with dry hide contact.
spatulate fragment	1	No Provenience	Artiodactyla	metapodial diaphysis	78.5	20	7.5	Mesio-distal portion of larger tool. Blank prepared by grooving and snapping, followed by grinding to final shape. Bright, invasive polish with rounding of high points present. Micro-pitting common, with common transverse, fine, smooth-edged striations on lateral edges. Use wear consistent with dry hide contact.
spatulate fragment	1	No Provenience	Artiodactyla	fibula distal diaphysis	71	11	5	Proximal portion of larger heavily weathered and carnivore-ravaged tool with remnant use wear polish on outer surface. Weathering and carnivore-ravaging has removed manufacturing evidence. Limited areas of unknown type of use wear

Form	#	Cultural Context	Taxon	Element	Length (mm)	Width (mm)	Thick-ness (mm)	Comments
								polish remain on high points, with evident faint longitudinal striations.
spatulate fragment	1	Historic – Late Prehistoric	Mammalia	tibia, proximal diaphysis	21	5	4	Medial fragment of larger tool manufactured from medium-sized mammal long bone fragment with a U-shaped cross-section. Blank prepared from helically fractured butchering waste by scraping and grinding to final shape. Multiple uses are indicated by medium, non-invasive polish and rounding of high points (use with silica-rich plants) and bright invasive polish and rounding on edges with micro-pitting evident (use with dry hide).
spatulate fragment	1	Historic – Late Prehistoric	Mammalia	rib, distal diaphysis	32.5	9.5	4	Distal fragment of longer tool manufactured from medium to large-sized mammal. Tip is wide and slightly rounded on a long narrow tool. Cross section of tip section is oval and 7 mm wide. larger tool manufactured on thin-walled element. Blank prepared by unknown method, followed by scraping to final shape. Bright non-invasive polish with slight rounding of high points. Few oblique smooth-edged fine to medium striations on distal end are consistent with use wear from wood contact.

Form	#	Cultural Context	Taxon	Element	Length (mm)	Width (mm)	Thick-ness (mm)	Comments
spatulate fragment	1	Terminal Late Archaic	Mammalia	indeterminate long bone	46	14	8	Distal portion of larger tool, with proximal carnivore ravaging. Blank prepared by grooving and snapping, followed by scraping and grinding to final shape. Bright non-invasive polish and rounding are present on high points. Common fine and medium transverse striations visible on lateral edges, outer surface, and inner surface high points, consistent with use wear from contact by silica-rich plants.
spatulate fragment	1	Late Archaic	Mammalia	indeterminate long bone	25	8	4	Lateral portion of larger tool manufactured on thin-walled element. Blank prepared by un-known method, followed by scraping to final shape. Tool fragment was partially burned, making exact use wear determination difficult. Medium non-invasive polish and slight rounding of high points. Use wear is consistent with contact by silica-rich plants.

Form	#	Cultural Context	Taxon	Element	Length (mm)	Width (mm)	Thick-ness (mm)	Comments
spatulate fragment	1	Late Archaic	Mammalia	indeterminate long bone	45	11.5	7	Latero-medial fragment of larger, longitudinally split tool that has been weathered. Prominent evidence of longitudinal groove and snap process of blank production on proximal end. Blank prepared by grooving and snapping, followed by scraping and distal grinding to final shape. Bright non-invasive polish and rounding are present on high points. Fine sharp edged transverse striations visible distally, consistent with use wear from contact by silica-rich plants.
spatulate fragment	1	No Provenience	Mammalia	indeterminate long bone	17	6	3	Distal fragment of longer tool. Constricted, narrowly beveled tip with oval cross section is 3 mm wide. Blank prepared by unknown method, followed by scraping and grinding to final shape. Bright non-invasive polish and rounding of high points. Fine oblique and transverse sharp-edged striations present and consistent with use wear from contact with silica-rich plants.
spatulate fragment	1	Historic – Late Prehistoric	*Odocoileus* sp.	metatarsal, proximal lateral diaphysis	156	20	6	Almost complete long, narrow tool. Specimen very weathered with no remnant use wear. Tip section constricted and oval in profile, 3 mm wide. A portion of the tip is

Form	#	Cultural Context	Taxon	Element	Length (mm)	Width (mm)	Thick-ness (mm)	Comments
								present. Blank prepared by grooving and snapping, with subsequent final shaping by grinding.
spatulate fragment	1	Historic – Late Prehistoric	*Odocoileus* sp.	metacarpal diaphysis	46	14	6	Medial segment of refitted larger tool or debitage with distal groove/snap fracture. Tool fragment weathered and delaminated, with no remnant use wear. Blank prepared by grooving and snapping, with scraping to final shape.
spatulate fragment	1	Terminal Late Archaic	*Odocoileus* sp.	metatarsal, proximal lateral diaphysis	115	25	8	Proximal to medial segment of long, weathered tool with surface pitting and discoloration, etching, and longitudinal cracking/splitting. Blank prepared by grooving and snapping, with scraping and grinding to final shape. Limited areas of polish consist of non-invasive polish on high points and fine transverse striations on lateral edge. Transverse use wear grooves on disto-medial lateral surfaces. Use wear consistent with contact from silica-rich plants.
spatulate fragment	1	Terminal Late Archaic	*Odocoileus* sp.	metatarsal, proximal diaphysis	80	14.5	8	Proximal portion of larger tool with terminal transverse dry state fracture. Two or more longitudinal weathering cracks present. Blank prepared by grooving and snapping, with medial and distal grinding to

Form	#	Cultural Context	Taxon	Element	Length (mm)	Width (mm)	Thick-ness (mm)	Comments
								final shape. Bright, non-invasive polish is present on high points. Fine, sharp-edged transverse striations visible on high points distally are consistent with use wear from contact with silica-rich plants.
spatulate	1	Terminal Late Archaic	*Odocoileus* sp.	metatarsal, proximal epiphysis and diaphysis	89	13	9	Complete medium length, narrow tool. Tip section is constricted and has a 3.5 mm wide oval cross section. The tip profile is sharp, but beveled and reworked by rodent gnawing. Blank prepared by grooving and snapping, followed by scraping and grinding to final shape. Bright non-invasive polish and slight rounding on high points are present. Transverse fine to medium sharp edged striations are evident on medial and distal portions of the tool and are consistent with use wear from contact with silica-rich plants.

Form	#	Cultural Context	Taxon	Element	Length (mm)	Width (mm)	Thick-ness (mm)	Comments
spatulate fragment	1	Terminal Late Archaic	*Odocoileus* sp.	metapodial diaphysis	71	10	6	Two conjoining fragments from latero-distal portion of larger tool that is split longitudinally and has tip section absent. Tool fragment is weathered, with considerable surface pitting. Blank prepared by unknown method, followed by grinding to final shape. Bright non-invasive polish and rounding on high points are present. Fine transverse sharp-edged striations present on high points are consistent with use wear from contact with silica-rich plants.
spatulate fragment	1	Terminal Late Archaic	*Odocoileus* sp.	metacarpal diaphysis	76	14	9	Distal portion of larger tool with distal terminal fracture about 20 mm from tip. Cross section at this point is oval in shape. Blank prepared by chopping, followed by scraping and grinding to final shape. Artifact burned, making exact use wear determination difficult. Bright, slightly invasive polish present with some rounding on high points. Fine smooth edged transverse striations visible on polished areas distally are consistent with use wear from wood contact.

Form	#	Cultural Context	Taxon	Element	Length (mm)	Width (mm)	Thick-ness (mm)	Comments
spatulate fragment	1	Terminal Late Archaic	*Odocoileus* sp.	metatarsal, proximal diaphysis	47.5	19.5	7.5	Proximal portion of larger tool that was burned to calcination. Blank prepared by grooving and snapping, followed by scraping and grinding to final shape. Artifact calcined, making exact use wear determination difficult. Medium non-invasive polish and rounding of high points present. Fine sharp edged transverse striations observed on high points proximally are consistent with use wear from contact with silica-rich plants.
spatulate fragment	1	Terminal Late Archaic	*Odocoileus* sp.	metatarsal, proximal epiphysis and diaphysis	110	14.5	7	Proximo-lateral portion of refitted, broken larger tool. Right lateral edge has remnants of longitudinal groove/snap that split the tool lengthwise and heavy longitudinal scraping distally to reshape it. Left lateral edge has five transverse use wear grooves, the distal one very prominent and extending across dorsal and ventral surfaces. Blank prepared by grooving and snapping, followed by scraping and grinding to final shape. Bright non-invasive polish and rounding of high points. Fine to medium transverse sharp-edged striations on high points along left lateral edge and ventral side are consistent with use wear

Form	#	Cultural Context	Taxon	Element	Length (mm)	Width (mm)	Thick-ness (mm)	Comments
								from contact with silica-rich plants.
spatulate fragment	1	Terminal Late Archaic	*Odocoileus* sp.	metatarsal, proximal epiphysis and diaphysis	41	25	10	Two conjoining fragments form the proximal portion of a moderately weathered longer tool. Blank prepared by grooving and snapping, followed by scraping to final shape. Tool fragments burned, making exact use wear determination difficult. Bright non-invasive polish and rounding on high points. Multiple medium transverse striations visible on left lateral edge medially are consistent with use wear from contact with silica-rich plants.
spatulate fragment	1	Terminal Late Archaic	*Odocoileus* sp.	metacarpal diaphysis	63	14	10.5	Medial portion of larger fragment. Fragment completely burned, with upper edges rounded making exact use wear difficult. At least three conchoidal fractures are evident on interior of tool and upper surface being somewhat wavy. This suggests blank extraction using a method other than groove and snap, instead possibly through precisely controlled helical fracture induced from the lateral margins. Blank further prepared by scraping and scraping to final shape. Use wear suggests wet hide.

Form	#	Cultural Context	Taxon	Element	Length (mm)	Width (mm)	Thick-ness (mm)	Comments
spatulate fragment	1	Terminal Late Archaic	*Odocoileus* sp.	metatarsal diaphysis	74	14	7	Disto-lateral portion of longer tool exhibits refitting following longitudinal fragmentation, with distal grinding and polishing along dry-state fracture. Fragment significantly weathered, with delamination and longitudinal cracking. Blank prepared by grooving and snapping, followed by scraping and grinding to final shape. Bright, non-invasive polish and rounding of high points. Two medium to wide shallow transverse grooves on ventral surface, with fine transverse sharp-edged striations on high points consistent with use wear from contact with silica-rich plants.
spatulate fragment	1	Terminal Late Archaic	*Odocoileus* sp.	metatarsal, proximal epiphysis	28.5	17.5	8	Proximal portion of longer tool. Blank prepared by grooving and snapping, followed by scraping to final shape. Bright invasive polish is present with rounding of high points. Micro-pitting is common, consistent with use wear from dry hide.
spatulate fragment	1	Terminal Late Archaic	*Odocoileus* sp.	metatarsal diaphysis	42	16	8.5	Proximo-lateral portion of longitudinally split larger tool. Blank prepared by grooving and snapping, followed by scraping and grinding to final shape. Item

Form	#	Cultural Context	Taxon	Element	Length (mm)	Width (mm)	Thick-ness (mm)	Comments
								burned, making exact use wear determination difficult. Tool fragment has 5+ transverse partial use wear grooves on ventral aspect. Bright, non-invasive polish and rounding on high points. Few fine to medium smooth-edged transverse striations on high points, consistent with use wear from contact with wood.
spatulate fragment	1	Terminal Late Archaic	*Odocoileus* sp.	metatarsal, proximal epiphysis and diaphysis	70	11	7	Proximo-lateral portion of larger tool. Blank prepared by grooving and snapping, followed by scraping and grinding to final shape. Bright non-invasive polish and rounding on high points. Fine sharp-edged transverse striations on high points are consistent with use wear from contact with silica-rich plants.
spatulate fragment	1	Terminal Late Archaic	*Odocoileus* sp.	metatarsal, proximal diaphysis	66	11	7	Proximo-lateral portion of larger tool. Blank prepared from helically fractured butchering waste and very minimally shaped by scraping and grinding. Bright non-invasive polish and rounding on high points are present. Fine distal sharp-edged transverse striations are consistent with use wear from contact with silica-rich plants.
spatulate fragment	1	Terminal	*Odocoileus* sp.	metatarsal, proximal	96	16	11	Proximal fragment of weathered, longitudinally split larger tool. Two

Form	#	Cultural Context	Taxon	Element	Length (mm)	Width (mm)	Thick-ness (mm)	Comments
fragment		Late Archaic		epiphysis and diaphysis				different types of lateral longitudinal fractures are visible, suggesting that the tool was refitted. Blank prepared by grooving and snapping, followed by scraping and grinding to final shape. Bright non-invasive polish and rounding of high points are present. Fine, smooth-edged, transverse striations present on high points distally are consistent with use wear from contact with wood.
spatulate fragment	1	Terminal Late Archaic	*Odocoileus* sp.	metatarsal, proximal epiphysis and diaphysis	76	19	9	Proximal portion of larger tool that has a distal terminal dry state fracture. Outer face of bone smoothed only on high points and retains roughened surface texture typical of subadult. Blank prepared by chopping, followed by grinding to final shape. Bright slightly invasive on high points and some low points. Smooth transverse striations noted distally are consistent with use wear from contact with wood.
spatulate fragment	1	Terminal Late Archaic	*Odocoileus* sp.	metatarsal, proximal epiphysis and diaphysis	132	28	13	Two conjoining fragments of proximal section of larger tool. Artifact is weathered and longitudinally fractured. Blank prepared by grooving and snapping, followed by scraping and grinding to final

Form	#	Cultural Context	Taxon	Element	Length (mm)	Width (mm)	Thick-ness (mm)	Comments
								shape. Bright, non-invasive polish and rounding on high points are present. Fine sharp-edged transverse striations present distally are consistent with use wear from contact with silica-rich plants.
spatulate fragment	1	Terminal Late Archaic	*Odocoileus* sp.	metatarsal diaphysis	62	13	7	Disto-lateral portion of longer tool. Blank prepared by grooving and snapping, followed by scraping and grinding to final shape. Fragment slightly burned proximally, but use wear does not appear to be affected. Medium to bright non-invasive polish and rounding are present on high points. Multiple use wear grooves are visible on lateral edge distally. Fine smooth-edged transverse striations are common on high points, consistent with use wear from contact with wood.
spatulate fragment	1	Terminal Late Archaic	*Odocoileus* sp.	metatarsal, proximal epiphysis and diaphysis	89	17	10	Proximo-medial portion of longer tool that appears to have been manufactured from a longitudinally quartered metatarsal. Dissimilar lateral fractures suggest refitting from a larger tool. One is a groove and snap, the other is a smoothed dry-state longitudinal fracture. Blank prepared by grooving and snapping, followed by scraping and grinding to final shape. Bright non-

Form	#	Cultural Context	Taxon	Element	Length (mm)	Width (mm)	Thick-ness (mm)	Comments
								invasive polish and rounding are present on high points. Osteons are visible, consistent with use wear from contact with wood.
spatulate fragment	1	Terminal Late Archaic	*Odocoileus* sp.	metatarsal, proximal epiphysis	48	25	12	Proximo-lateral portion of longitudinally fractured tool that is root-etched. Blank prepared by grooving and snapping, followed by minimal modification to final shape. Bright invasive polish with rounding of high points is suggestive of use wear consistent with wood contact.
spatulate fragment	1	Terminal Late Archaic	*Odocoileus* sp.	metatarsal, proximal epiphysis and diaphysis	95	20	13	Proximal portion of weathered larger tool manufactured from a longitudinally quartered metatarsal. Blank prepared by grooving and snapping, followed by scraping to final shape. Bright, non-invasive polish and rounding present on high points. Oblique medium grooves from use wear are visible on right upper lateral edge. Transverse sharp-edged striations also visible, consistent with use wear from contact with silica-rich plants.

Form	#	Cultural Context	Taxon	Element	Length (mm)	Width (mm)	Thick-ness (mm)	Comments
spatulate fragment	1	Terminal Late Archaic	*Odocoileus* sp.	metatarsal, proximal epiphysis and diaphysis	67	27	12	Proximal portion of weathered larger tool, with distal longitudinal desiccation cracks. Blank prepared by grooving and snapping, with scraping and grinding to final shape. Bright non-invasive polish and rounding on high points and fine sharp-edged transverse striations present distally are use wear from contact with silica-rich plants.
spatulate fragment	1	Terminal Late Archaic	*Odocoileus* sp.	metatarsal, proximal epiphysis and diaphysis	57	16	10	Proximo-lateral portion of weathered larger tool with common root-etching. Blank prepared by grooving and snapping, with scraping to final shape. Bright non-invasive and rounding on high point present. Fine sharp-edged transverse striations distally, consistent with use wear from contact with silica-rich plants.
spatulate fragment	1	Terminal Late Archaic	*Odocoileus* sp.	metatarsal, proximal epiphysis and diaphysis	34	19	11	Proximo-lateral portion of weathered larger tool. Blank prepared by grooving and snapping, with minimal modification to final shape. Bright invasive polish and rounding on high points suggestive of dry hide use wear.
spatulate fragment	1	Terminal Late Archaic	*Odocoileus* sp.	metatarsal, proximal diaphysis	118	21	8	Medio-distal portion of larger tool that has evidence of weathering with delamination. Distal break

Form	#	Cultural Context	Taxon	Element	Length (mm)	Width (mm)	Thick-ness (mm)	Comments
								shows field repair of portion now missing from tip. Blank prepared by grooving and snapping, with scraping and grinding to final shape. Internal surface scraped. Non-invasive polish on high points, six transverse use wear grooves are evident on one lateral edge, extending across face of outer aspect. Longitudinal striations on distal tip, transverse on rest, suggestive of use wear from contact with silica-rich plants.
spatulate fragment	1	Terminal Late Archaic	*Odocoileus* sp.	metatarsal, proximal diaphysis	79	21.5	9	Proximo-lateral fragment of very weathered larger tool that retains use wear. Blank prepared by grooving and snapping, followed by scraping and grinding to final shape. Bright invasive polish, with rounding of high points is present. Transverse striations present on lateral edge and ventral aspect. Striations are narrow, smooth-edged, and grouped, use wear that is consistent with wood contact.
spatulate fragment	1	Terminal Late Archaic	*Odocoileus* sp.	metatarsal diaphysis	102	21	7	Three conjoining fragments form proximal portion of burned larger tool. Blank prepared by grooving and snapping, followed by scraping and grinding to final shape. Tool fragments burned, making exact use

Form	#	Cultural Context	Taxon	Element	Length (mm)	Width (mm)	Thick-ness (mm)	Comments
								wear determination difficult. Bright non-invasive polish and rounding of high points present. Medium and fine, sharp-edged, transverse striations on high points are consistent with use wear from contact with silica-rich plants.
spatulate fragment	1	Terminal Late Archaic	*Odocoileus* sp.	metapodial diaphysis	36	10	4	Distal portion of larger tool. Tip section is 4 mm wide, with a rounded tip on a gently tapering distal segment. Blank prepared by unknown method, followed by scraping and grinding to final shape. Bright non-invasive polish and rounding on high points. Sharp-edged, oblique fine striations at tip, transverse medially and proximally. Wear consistent with contact by silica-rich plants.
spatulate fragment	1	Terminal Late Archaic	*Odocoileus* sp.	metatarsal, proximal epiphysis and diaphysis	56	18	11	Proximo-lateral segment of larger weathered and partially delaminated tool. Distal terminal fracture is dry state, as is one lateral fracture. Blank prepared by unknown method, followed by scraping and grinding to final shape. Bright, non-invasive polish on high points suggests use wear from contact with silica-rich plants.

Form	#	Cultural Context	Taxon	Element	Length (mm)	Width (mm)	Thick-ness (mm)	Comments
spatulate fragment	1	Terminal Late Archaic	*Odocoileus* sp.	metatarsal, proximal epiphysis and diaphysis	109	27	12	Two conjoining fragments form part of the proximal portion of a very weathered larger tool that has lateral and distal dry state fractures and numerous longitudinal desiccation cracks. Blank prepared by grooving and snapping, followed by scraping and grinding to final shape. Bright, non-invasive polish present on high points, with rounding of edges and high points. Very common sharp-edged fine transverse striations on distal two-thirds consistent with use wear from contact by silica-rich plants.
spatulate fragment	1	Late Archaic	*Odocoileus* sp.	metacarpal diaphysis	71	14.5	7.5	Two conjoining fragments of medial section of larger tool. Surface extremely pitted and weathered, with no evident use wear remaining.
spatulate fragment	1	Late Archaic	*Odocoileus* sp.	metatarsal diaphysis	82	16	12	Proximal fragment of larger tool manufactured from a longitudinally quartered metatarsal. Tool fragment is badly weathered, with surface delamination and longitudinal desiccation cracking. Limited carnivore ravaging is also evident. Blank prepared by grooving and snapping, followed by scraping and medial – distal grinding to final shape. Bright non-

Form	#	Cultural Context	Taxon	Element	Length (mm)	Width (mm)	Thick-ness (mm)	Comments
								invasive polish and rounding of high points are present. Fine to medium sharp-edged transverse striations are evident distally, consistent with use wear from contact with silica-rich plants.
spatulate fragment	1	Late Archaic	*Odocoileus* sp.	metatarsal, proximal epiphysis and diaphysis	60	24	7	Proximal segment of burned larger tool. Blank prepared by grooving and snapping, followed by scraping and grinding to final shape. Artifact burned, making exact use wear determination difficult. Bright non-invasive polish and rounding on high points. Few fine sharp-edged transverse striations on lateral edges and high points are consistent with use wear from contact with silica-rich plants.
spatulate fragment	1	Late Archaic	*Odocoileus* sp.	metatarsal, proximal epiphysis and diaphysis	100	25	12	Proximal segment of heavily weathered larger tool. Blank prepared by grooving and snapping, followed by medial and distal grinding to final shape. Bright invasive polish with rounding of high points is present. Distal half has transverse, fine, grouped smooth-edged striations, consistent with use wear from wood contact.
spatulate fragment	1	Late Archaic	*Odocoileus* sp.	metacarpal diaphysis	40	12	6	Distal portion of larger tool. Blank prepared by unknown method, followed by scraping and grinding

Form	#	Cultural Context	Taxon	Element	Length (mm)	Width (mm)	Thick-ness (mm)	Comments
								to final shape. Bright non-invasive polish and rounding on high points. Fine oblique to transverse sharp-edged striations present on high points, with several medium sets proximally. Use wear is consistent with contact from silica-rich plants.
spatulate fragment	1	Late Archaic	*Odocoileus* sp.	metatarsal diaphysis	70	9.5	5	Latero-distal segment of refitted larger tool. Tool is now slightly asymmetric, with remnants of longitudinal fracture on left lateral edge and original upsweeping edge on right margin. Fragment is weathered with several longitudinal desiccation cracks. Tip section is oval in cross section, 2 mm wide, with slightly rounded very constricted tip profile. Blank prepared by grooving and snapping, followed by scraping and grinding to final shape. Ten transverse medium-width grooves are present proximally on left ventral margin and post-date refitting. Bright, non-invasive polish and rounding on high points are also present. Fine smooth-edged oblique striations distally, transverse striations proximally, consistent with use wear from wood contact.

Form	#	Cultural Context	Taxon	Element	Length (mm)	Width (mm)	Thick-ness (mm)	Comments
spatulate fragment	1	Late Archaic	*Odocoileus* sp.	metatarsal diaphysis	62	14	6	Distal segment of significantly weathered and pitted larger tool with several longitudinal desiccation cracks. Tool was refitted by longitudinal scraping to reshape the distal half and exhibits wear from further use. The tip was damaged during use following refitting, removing a 4 mm spall from the inner surface. Tip section has a gently rounded profile, with a 3 mm wide oval cross section. Blank prepared by grooving and snapping, followed by scraping to final shape. Bright non-invasive polish and rounding present on high points. Smooth-edged fine to medium transverse striations on high points proximally, with fine oblique striations distally, consistent with use wear from wood contact.
spatulate fragment	1	Middle Archaic	*Odocoileus* sp.	metacarpal diaphysis	22	10	5	Medio-distal segment of larger tool. Blank prepared by unknown method, followed by scraping and grinding to final shape. Fragment was partially burned, making exact use wear determination difficult. Medium bright non-invasive polish present. Fine to medium oblique striations present on lateral edges. Striations are smooth with rounded edges, consistent with use wear

Form	#	Cultural Context	Taxon	Element	Length (mm)	Width (mm)	Thick-ness (mm)	Comments
								from wood contact.
spatulate fragment	1	Middle Archaic	*Odocoileus* sp.	metacarpal diaphysis	30	11	5.5	Medial section of larger tool. Blank prepared by grooving and snapping, followed by scraping and grinding to final shape. Medium non-invasive polish on high points. Transverse fine to medium striations on upper edges with oblique fine striations on lateral edges. Striations are sharp-edged and consistent with use wear from contact with silica-rich plants.
spatulate fragment	1	Middle Archaic	*Odocoileus* sp.	metacarpal diaphysis	28	14	6	Medial section of larger tool. Blank prepared by grooving and snapping, followed by scraping and grinding to final shape. Bright non-invasive polish and rounding of high points are present. Fine sharp edged oblique striations on high points are consistent with use wear from contact with silica-rich plants.
spatulate fragment	1	Middle Archaic	*Odocoileus* sp.	metacarpal diaphysis	39	12	7	Distal section of larger tool. Blank prepared by grooving and snapping, followed by scraping and grinding to final shape. Micro-pitting is common. Bright non-invasive polish and rounding on high points are present. Fine, sharp edged, oblique striations are also present on high points and are consistent

Form	#	Cultural Context	Taxon	Element	Length (mm)	Width (mm)	Thick-ness (mm)	Comments
								with use wear from contact with silica-rich plants.
spatulate fragment	1	Middle Archaic	*Odocoileus* sp.	metatarsal, distal epiphysis	54	33	20	Proximal portion of larger tool with very good example of grooving and snapping of distal metatarsal for blank production. Scraping and grinding were used for final shaping. Bright non-invasive polish and rounding are present on high points. Three areas of transverse shallow use wear grooving are visible on upper surface of left lateral edge. Fine sharp-edged transverse striations ventrally are consistent with use wear from contact with silica-rich plants.
spatulate fragment	1	Middle Archaic	*Odocoileus* sp.	metatarsal, proximal epiphysis and diaphysis	41	17.5	8.5	Proximo-lateral portion of very weathered, larger tool. Blank prepared by grooving and snapping, followed by scraping and grinding to final shape. Bright non-invasive polish and rounding of high points are consistent with use wear from contact with silica-rich plants.
spatulate fragment	1	Middle Archaic	*Odocoileus* sp.	metatarsal diaphysis	29.5	10	5	Distal portion of larger tool. Blank prepared by unknown method, followed by scraping and grinding to final shape. Bright, non-invasive polish and rounding of high points. Fine to medium transverse smooth-edged striations present on high

Form	#	Cultural Context	Taxon	Element	Length (mm)	Width (mm)	Thick-ness (mm)	Comments
								points, consistent with wear from wood contact.
spatulate fragment	1	No Provenienc e	*Odocoileus* sp.	metatarsal diaphysis	45	15	6	Medial segment of calcined larger tool. Blank prepared by grooving and snapping, followed by scraping and grinding to final shape. Tool fragment burned, making exact use determination difficult. Bright non-invasive polish with rounding of high points and at least 8 rounded transverse grooves worn into upper surface. Fine transverse striations are visible on high points, suggestive of wear from contact with silica-rich plants.
spatulate / bodkin fragment	1	Terminal Late Archaic	Artiodactyla	metacarpal distal epiphysis and diaphysis	51	17	13	Proximal portion of larger tool, Distal fracture is dry state and lateral attrition has removed portions of proximal end of modified area. Tool manufactured from split metacarpal. Blank prepared by grooving and snapping, followed by scraping and grinding to final shape. Minor tear-out at distal end, with transverse striations on distal half suggestive of wear from contact with hide with hair.
spatulate / bodkin fragment	1	Terminal Late Archaic	Artiodactyla	phalange, 1st, distal epiphysis and diaphysis	95	17.5	15	Proximo-medial portion of larger tool lacks distal tip, but is manufactured from a heavily modified artiodactyl phalange.

Form	#	Cultural Context	Taxon	Element	Length (mm)	Width (mm)	Thick-ness (mm)	Comments
								Blank production on this element does not have characteristics of groove and snap used on more robust metapodials; it may have been by dynamic fracturing or chopping. Condyles are heavily modified by grinding. Element was scraped longitudinally to remove periosteum. Non-invasive polish on high points. Fine striations are evident oblique or transverse to long axis, suggestive of wear from contact with silica-rich plants.
spatulate / bodkin fragment	1	Terminal Late Archaic	*Odocoileus* sp.	metacarpal	47	21	16	Proximal portion of larger tool, with medial groove between condyles hollowed out. Blank prepared by unknown method, followed by grinding adjacent to condyles and scraping of diaphysis. Tool fragment burned, making use wear determination difficult. Non-invasive polish on high points. Fine transverse striations also evident, consistent with wear from contact with silica-rich plants.
spatulate / bodkin fragment	1	Terminal Late Archaic	*Odocoileus* sp.	metacarpal distal epiphysis condyle	30	18.5	9	Proximo-lateral segment of larger tool. Fragment is of heavily modified distal deer metacarpal. Outer surface of condyle is abraded into underlying cancellous bone, with remnants of polish, grinding,

Form	#	Cultural Context	Taxon	Element	Length (mm)	Width (mm)	Thick-ness (mm)	Comments
								and scraping present. Blank prepared by unknown method. Bright non-invasive polish on high points and lateral edges, consistent with wear from contact with silica-rich plants.
spatulate / bodkin fragment	1	Terminal Late Archaic	*Odocoileus* sp.	metacarpal distal epiphysis	83	17.5	17	Proximo-medial portion of burned larger tool. One distal condyle absent. Proximal outer surface of tool is abraded into underlying cancellous bone, with remnants of polish, grinding, and scraping present. Tip missing, but profile of distal end of tool is constricted laterally and beveled. Wavy edge of bevel suggests blank extraction method other than groove and snap. Diaphysis has been longitudinally scraped. Bright slightly invasive polish on high points and lateral edges. Upper edges of distal bevel are well rounded. Micro- pitting and transverse fine striations visible distally suggest use wear from dry hide.
spatulate / bodkin fragment	1	No Provenienc e	*Odocoileus* sp.	metacarpal diaphysis	108	17	8	Almost complete tool with significant carnivore-ravaging and root-etching. Tip section is very narrow versus length, 2 mm wide, and oval in cross section. Distal 1 mm of tip is absent. Blank has been

Form	#	Cultural Context	Taxon	Element	Length (mm)	Width (mm)	Thick-ness (mm)	Comments
								prepared using grooving and snapping, followed by scraping and grinding. Non-invasive polish on most of surface, with transverse fine striations over medial part of tool. Surface discoloration and polish are evident proximally. Use wear is consistent with contact by silica-rich plants.
spatulate / bodkin fragment	1	No Provenience	*Odocoileus* sp.	metacarpal distal diaphysis	120	17	16	Relatively complete proximo-medial segment of larger tool. Tip section missing, but break retains glue from field repair. Surface is pitted and carnivore ravaged. Metacarpal blank prepared by unknown method, with no evidence of groove and snap or dynamic fracturing remaining. Diaphysis has evidence of longitudinal scraping. Non-invasive polish evident on high points with fine transverse striations also noted, suggesting of contact by silica-rich plants.
spatulate / bodkin fragment	1	No Provenience	*Odocoileus* sp.	metacarpal distal epiphysis and diaphysis	73	19	10	Relatively complete proximo-medial segment of larger tool in relatively good condition, with minor crushing on surface near proximal end. Blank prepared by grooving and snapping, followed by scraping and grinding. Interior surface was scraped during

Form	#	Cultural Context	Taxon	Element	Length (mm)	Width (mm)	Thick-ness (mm)	Comments
								processing. Non-invasive polish on high points, with fine transversely-oriented striations on distal 2/3 of item, suggesting of contact by silica-rich plants.
spatulate, catfish spine	1	Terminal Late Archaic	*Ictalurus furcatus*	spine, pectoral	66	8	5	Narrow tool with width and thickness measurements taken at the base of the spine. Tip has relatively sharp profile, oval cross-section that is 3 mm wide, on long narrow tool manufactured using modified catfish spine. Medium non-invasive polish is present on ventral and dorsal aspects of spine. Fourteen shallow transverse grooves are evident worn into the ventral distal face of spine near tip. Use wear is consistent with contact by silica-rich plants.
spatulate, catfish spine	1	Terminal Late Archaic	*Ictalurus furcatus*	spine, pectoral	71	8	7.5	Narrow tool with width and thickness measurements taken at the base of the spine. Anterior and posterior portions of element have been modified to flatten profile. Extreme tip is damaged (post-depositional), possibly from weathering that has affected the tool. Tip section has been narrowed and beveled to pointed 3 mm wide profile on long narrow tool manufactured using modified

Form	#	Cultural Context	Taxon	Element	Length (mm)	Width (mm)	Thick-ness (mm)	Comments
								catfish spine. Spine has been modified to final shape by longitudinal scraping. Non-invasive polish is present on high points along most of artifact shaft, consistent with use wear from silica-rich plants.
spatulate, catfish spine	1	Terminal Late Archaic	*Ictalurus furcatus*	spine, pectoral	76	9	4	Narrow tool with width and thickness measurements taken at the base of the spine. Specimen has deep cut mark on articulation to “disarm” muscles controlling spine-locking mechanism. Tip section has been narrowed by distal grinding to a pointed 4 mm wide profile on long narrow tool manufactured using modified catfish spine. Surface is polished. Bright, invasive polish is present with smooth, relatively rounded edges. Few striations, if any, are visible. Osteons are visible, consistent with use wear produced by wet hide.
spatulate, catfish spine	1	Terminal Late Archaic	*Ictalurus punctatus*	spine, pectoral	66	7.5	4.5	Weathered narrow tool with width and thickness measurements taken at the base of the spine. Element has portion of articulation absent. Tapering, constricted tip profile on long tool with flattened oval cross section manufactured using modified catfish spine. Tip section

Form	#	Cultural Context	Taxon	Element	Length (mm)	Width (mm)	Thick-ness (mm)	Comments
								is 2 mm wide. Spine has been modified to final shape by longitudinal scraping and grinding. Bright, invasive polish is present on high points. Weak relatively smooth striations are visible on posterior edge of element, consistent with use wear produced by dry hide.
spatulate fragment, catfish spine	1	Terminal Late Archaic	*Ictalurus punctatus*	spine, pectoral	30	4	2.5	Distal portion of long narrow tool manufactured from modified catfish spine, with proximal dry-state fracture. Tip is constricted, has an oval cross section, and is 2.5 mm. Tool modification minimal. Non-invasive polish on high points is present, with fine oblique striations present on distal end of tool. Wear consistent with contact by silica-rich plants during use.
spatulate fragment, catfish spine	1	Terminal Late Archaic	*Ictalurus furcatus*	spine, pectoral	19	5	4	Distal portion of long narrow tool manufactured from modified catfish spine. Extreme distal tip missing, but width at terminal fracture is 2.5 mm with an oval cross section. Modification of natural shape of catfish spine was by longitudinal scraping. Surface modification left surface alteration, but did not alter general shape to a great degree. No obvious use wear remains.

Form	#	Cultural Context	Taxon	Element	Length (mm)	Width (mm)	Thick-ness (mm)	Comments
spatulate fragment, creaser	1	Terminal Late Archaic	Artiodactyla	metacarpal diaphysis	53	10	5	Distal portion of long narrow tool with narrow, tapered, beveled tip section. Cross section of tip is a narrow oval, 3 mm wide, with a rounded end profile. Specimen has minor carnivore ravaging and root etching. Blank prepared by chopping, followed by scraping and grinding to final shape. Bright, invasive polish with rounding of surface is present, including rounded and beveled tip section that has few fine pits and oblique striations in direction of bevel. Wear is consistent with wet hide use.
spatulate, distally notched	1	Middle Archaic	Artiodactyla	metacarpal diaphysis	55	15.5	6	Distal portion of long narrow tool with blunt, bifurcated tip section. Bifurcation is 2.5 mm deep, with two tips about 5 mm wide and 3 mm thick each. Tip cross section oval with a width of 13 mm. Blank prepared from helically fractured fragment by scraping and grinding to final shape. Bright, non-invasive polish on high points result in dimpled surface appearance. Very few striations, with sharp and smooth edges. Use wear consistent with sinew contact.

Form	#	Cultural Context	Taxon	Element	Length (mm)	Width (mm)	Thick-ness (mm)	Comments
spatulate, distally notched	1	Middle Archaic	Artiodactyla	metacarpal diaphysis	20	13.5	7	Distal portion of short, relatively wide tool with beveled base and blunt bifurcated tip section. Bifurcation is 8 mm deep, with two tips about 5 mm wide and 3 mm thick. One tip is slightly battered, the other has snap fracture removing about 2.5 mm of its length. Proximal end is beveled, with partial snap fracture. One side thicker than other. Blank prepared by unknown method prior to final shaping by scraping. Artifact burned, making exact use wear determination difficult. Bright non-invasive polish and limited rounding are present on high points. Fine oblique smooth-edged striations on distal tips are consistent with use wear produced by wood contact.
spatulate, distally notched	1	Middle Archaic	Mammalia	humerus diaphysis	49	11	10	Almost complete tool manufactured from distal end of helically fractured medium to large mammal humerus. Bifurcated tip has been scraped to final shape and exhibits tear-out on one side and terminal fracture on other. Bifurcation is 6 mm deep, with two tips about 2 - 3 mm wide and 1 - 3 mm thick. Bright non-invasive polish and slight rounding on high points are

Form	#	Cultural Context	Taxon	Element	Length (mm)	Width (mm)	Thick-ness (mm)	Comments
								present. Few oblique smooth striations are consistent with use for hide with hair.
spatulate fragment, incised	1	Historic – Late Prehistoric	Artiodactyla	metapodial diaphysis	44	11	4	Disto-lateral fragment of carnivore-ravaged, larger, decorated tool. Two transverse grooves are present proximally, including one at the proximal fracture. Blank prepared by grooving and snapping, followed by scraping to final shape. Burned, making exact use wear determination difficult. Medium non-invasive polish and rounding observed on high points. Fine transverse striations are present on high points. Striations are smooth-edged and consistent with use wear from wood contact.
spatulate fragment, incised	1	Terminal Late Archaic	Artiodactyla	metapodial diaphysis	28	12	6	Medial fragment of a larger tool that is partially burned on external aspect. Blank prepared by grooving and snapping, followed by scraping to final shape. Four transverse grooves were then incised into external aspect at 3 mm intervals. Bright non-invasive polish on high points with limited pitting, common striations with sharp-edged striations. Use wear is consistent with contact by silica-rich plants.

Form	#	Cultural Context	Taxon	Element	Length (mm)	Width (mm)	Thick-ness (mm)	Comments
spatulate fragment, incised	1	Terminal Late Archaic	Artiodactyla	indeterminate long bone	52	13	7	Proximal segment of heavily weathered tool with small areas of remnant polish of unknown origin along lateral edges and outer surface. Blank prepared by unknown method and ground to final shape. No apparent use wear polish noted on fragment.
spatulate fragment, incised	1	Terminal Late Archaic	Artiodactyla	metapodial diaphysis	43	16	5	Proximo-lateral segment of decorated spatulate with flattened cross section that may be remnant of an originally wider tool. Decoration consists of distinct incised cross-hatching along lateral edge of fragment. Cross-hatching has smooth edges at 30x magnification. Blank prepared by grooving and snapping, followed by scraping and grinding to final shape prior to decoration by incising of cross-hatching. Transverse to oblique scratching and striations are present and consistent with use wear from contact by silica-rich plants.
spatulate fragment, incised	1	Terminal Late Archaic	Artiodactyla	metapodial diaphysis	29	9	5	Medio-lateral fragment of larger decorated spatulate from medio-distal portion of tool at transition from wide U-shaped to oval cross section. Decoration consists of incised cross-hatching and 4 distinct

Form	#	Cultural Context	Taxon	Element	Length (mm)	Width (mm)	Thick-ness (mm)	Comments
								chevrons. Decoration may have ochre filling. Decoration at this longitudinal point may indicate refitting of broken tool. Blank prepared by grooving and snapping, followed by scraping and grinding to final shape prior to decoration by incising of cross-hatching. Osteons are visible, indicating polishing involving wet hide or wood. Bright, non-invasive polish on high points, with many fine, transverse and oblique striations. Use wear consistent with contact by silica-rich plants.
spatulate fragment, incised	1	Terminal Late Archaic	Artiodactyla	metatarsal diaphysis	53.5	24	6	Proximal portion of larger decorated spatulate. Distal fracture is dry state, diagonally terminating the specimen. Proximal end is broadly rounded and smoothed. It was scraped during manufacture. Incised cross-hatching on lateral edges of outer surface on proximal end begins about 7 mm from proximal end and extends 26 mm along one side and to terminal fracture on other. Blank prepared by grooving and snapping, followed by scraping and grinding, and polishing to final shape prior to decoration by incising of cross-hatching. Bright non-invasive

Form	#	Cultural Context	Taxon	Element	Length (mm)	Width (mm)	Thick-ness (mm)	Comments
								polish present, with rounding of high points. Fine transverse striations are evident on the outer surface distally. Striations are sharp edged, consistent with use wear from silica-rich plants.
spatulate fragment, incised	1	Terminal Late Archaic	Artiodactyla	metapodial diaphysis	42	10	4	Latero-proximal portion of larger decorated spatulate with longitudinal dry-state fracture. Remnants of drilled hole on left side of proximal end near lon-gitudinal fracture. Five incised lines form several chevrons on outer surface of proximal lateral edge and a prominent transverse line across proximal end. Significant rodent gnawing present. Blank prepared by grooving and snapping, followed by scraping and grinding, and polishing to final shape prior to decoration by incising of cross-hatching. Bright non-invasive polish and rounding of high points. Fine transverse smooth-edged striations present on ventral aspect are consistent with use wear from wood.
spatulate fragment, incised	1	Terminal Late Archaic	Artiodactyla	metapodial diaphysis	28	12	6	Medial portion of larger tool with four transverse grooves incised into outer surface at 3 mm intervals. Blank prepared by unknown

Form	#	Cultural Context	Taxon	Element	Length (mm)	Width (mm)	Thick-ness (mm)	Comments
								method, then scraped to final shape before grooves were incised. Bright non-invasive polish present on high points with limited pitting and common sharp-edged striations, consistent with use wear from contact with silica-rich plants.
spatulate fragment, incised	1	Middle Archaic	Artiodactyla	metapodial diaphysis	37	8	5	Medio-lateral segment of longitudinally split tool. Fractures are dry-state. High points on lateral edge show remnants of 5 short oblique grooves. Blank prepared by grooving and snapping, followed by scraping to final shape prior to decoration by incising. Bright, strong, invasive polish with extensive rounding present. Fine smooth-edged oblique striations parallel grooving, with fine transverse striations also present on high points. Use wear consistent with dry hide.
spatulate fragment	1	Terminal Late Archaic	*Odocoileus* sp.	metatarsal diaphysis	46	16	7	Proximal fragment of weathered larger tool with significant longitudinal desiccation cracking. Blank prepared by grooving and snapping, followed by scraping and grinding to final shape prior to decoration by incising of oblique lines or cross-hatching. Three sets of oblique parallel grooves incised

Form	#	Cultural Context	Taxon	Element	Length (mm)	Width (mm)	Thick-ness (mm)	Comments
								across outer surface, distal set at about 45-degree angle to other sets. Bright, non-invasive polish and rounding are present on high points. Sharp-edged medium to fine transverse striations present on outer surface, consistent with use wear from contact with silica-rich plants.
spatulate fragment, narrow	1	Historic – Late Prehistoric	Artiodactyla	metapodial diaphysis	38	13	6	Medio-distal portion of larger tool. Blank prepared by grooving and snapping, followed by scraping and grinding to final shape. Bright non-invasive polish and rounding on high points. Fine sharp-edged transverse striations are present on high points and consistent with use wear from contact by silica-rich plants.
spatulate fragment, narrow	1	Terminal Late Archaic	Artiodactyla	metatarsal, proximal diaphysis	85	11	7.5	Almost compete narrow tool with damaged tip section. Item manufactured from juvenile or subadult individual that is missing proximal epiphysis at growth plate. Blank prepared by grooving and snapping, followed by scraping and grinding to final shape. Bright non-invasive polish and rounding present on high points. Transverse fine striations medial, with oblique fine striations distal. Striations are sharp-edged and consistent with use

Form	#	Cultural Context	Taxon	Element	Length (mm)	Width (mm)	Thick-ness (mm)	Comments
								wear from contact by silica-rich plants.
spatulate fragment, narrow	1	Terminal Late Archaic	Artiodactyla	metapodial diaphysis	41	7.5	4.5	Distal portion of weathered larger tool with several desiccation cracks. Tool fragment has remnant of transverse groove/snap on proximal end. Blank prepared by grooving and snapping, followed by scraping to final shape. Medium non-invasive polish and slight rounding of high points observed. Very fine smooth-edged transverse striations present on high points. Use wear consistent with that produced by wood.
spatulate fragment, narrow	1	Middle Archaic	Artiodactyla	metatarsal, diaphysis	40	7.5	6	Medial portion of larger tool. Blank prepared by grooving and snapping, followed by scraping to final shape. Bright non-invasive polish and rounding present on high points. Fine sharp-edged oblique striations visible on high point on proximal end are consistent with use wear from contact by silica-rich plant.
spatulate fragment, narrow	1	Terminal Late Archaic	Mammalia	indeterminate long bone	42.5	7.5	3.5	Medial portion of tool manufactured from a medium to large mammal-sized long bone. The tool fragment has a triangular cross section that tapers slightly towards distal end. Blank prepared by unknown method, followed by

Form	#	Cultural Context	Taxon	Element	Length (mm)	Width (mm)	Thick-ness (mm)	Comments
								scraping to final shape. Bright slightly invasive polish present on high points and some low areas. Smooth, rounded striations present, but exhibit multiple directions. Use wear consistent with that produced by dry hide.
spatulate, ulna	1	Terminal Late Archaic	Artiodactyla	ulna, proximal epiphysis	70	33	15	Proximal portion of larger tool. Blank prepared by grooving and snapping, with approximately 10 deep cutmarks parallel to the groove/snap fracture, followed by scraping and grinding to final shape.
spatulate, ulna	1	Terminal Late Archaic	*Odocoileus* sp.	ulna, proximal epiphysis	62	36	17	Proximal portion of larger tool. Blank prepared by unknown method, followed by distal scraping to final shape. Bright non-invasive polish and slight rounding on high points are present. Oblique sharp-edged fine striations present distally are consistent with use wear from silica-rich plants.
spatulate, ulna	1	Terminal Late Archaic	*Odocoileus* sp.	ulna, proximal epiphysis and diaphysis	83.5	33	19	Proximal and medial portion of larger weathered tool that retains use wear polish although portions of surface are eroded. Little modification to blank except the longitudinal grooves incised on each side under the articulation. Very bright invasive polish and rounding of

Form	#	Cultural Context	Taxon	Element	Length (mm)	Width (mm)	Thick-ness (mm)	Comments
								high points, especially distally. Surface appears to be “dimpled”. Fine smooth-edged transverse striations distally are consistent with use wear from wood.
spatulate, ulna	1	Terminal Late Archaic	*Odocoileus* sp.	ulna, proximal diaphysis with articulation	103	34	15	Almost complete tool with significant weathering damage and delamination. Distal fracture is dry-state and occurred as post-depositional breakage. Tip width measurement of 4.5 mm taken at that point. Seven narrow rounded grooves are found immediately distal to the articulation on both the caudal and cranial aspects, possibly relating to hafting. Blank prepared by unknown method, followed by distal scraping to final shape. Minor transverse distal striations, rounding, and polish on high points and on grooved areas around possible haft Invasive polish distal to haft modification, includes extensive small transverse striations consistent with dry hide use.
spatulate, ulna	1	Terminal Late Archaic	*Odocoileus* sp.	ulna, proximal epiphysis and diaphysis with articulation	125	45	20	Complete tool. Tip is 3.5 mm wide and oval in cross section with very constricted profile. Blank has been laterally chopped in areas around articulation and then ground to produce grip, then diaphysis distal

Form	#	Cultural Context	Taxon	Element	Length (mm)	Width (mm)	Thick-ness (mm)	Comments
								to articulation has been longitudinally scraped. Tip section has been ground to shape. Non-invasive polish is present on high points on medial and distal portion of artifact, tip is slightly discolored. Wear is consistent with use with silica-rich plants.
spatulate manufacturing debitage	1	No Provenience	*Odocoileus* sp.	tibia, distal diaphysis	81	23	17	Heavily built element, possibly from large adult male. Diaphysis scraped to remove periosteum before transverse groove and snap used to remove distal epiphysis. One helical fracture is present and forms part of proximal margin. No evidence is present of additional shaping or subsequent use wear.
spatulate manufacturing debitage	1	Terminal Late Archaic	Artiodactyla	metatarsal diaphysis	59	11	5	Medial segment of debitage fragment from metatarsal diaphysis from subadult individual, with cutmarks and groove and snap fracture. Fragment was longitudinally split by grooving and snapping with no evidence of additional shaping or subsequent use wear.
spatulate manufacturing debitage	1	Terminal Late Archaic	Artiodactyla	tibia diaphysis	53	22	13	Lateral segment of debitage fragment from tibia diaphysis. Specimen burned. Distal fracture is wide groove/snap. Proximal fracture is dry state. Fragment was

Form	#	Cultural Context	Taxon	Element	Length (mm)	Width (mm)	Thick-ness (mm)	Comments
								longitudinally split by grooving and snapping with no evidence of additional shaping or subsequent use wear.
spatulate manufacturing debitage	1	Terminal Late Archaic	Artiodactyla	metatarsal diaphysis	39	15	7.5	Medial segment of debitage fragment from metatarsal diaphysis longitudinally split by grooving and snapping with no evidence of additional shaping or subsequent use wear.
spatulate manufacturing debitage	1	Terminal Late Archaic	Artiodactyla	metatarsal diaphysis	17	15	4	Proximal segment of debitage fragment from metatarsal diaphysis longitudinally split by grooving and snapping accompanied by longitudinal scraping to either begin shaping or to remove the periosteum. Fragment burned, but has no evidence of subsequent use wear.
spatulate manufacturing debitage	1	Terminal Late Archaic	Artiodactyla	metapodial diaphysis	45	5	3	Lateral segment of debitage fragment from metapodial diaphysis longitudinally split by grooving and snapping accompanied by longitudinal scraping to either begin shaping or to remove the periosteum. Medium bright non-invasive polish and slight rounding on high points indicate wear from contact with wood, possibly during the manufacturing process.

Form	#	Cultural Context	Taxon	Element	Length (mm)	Width (mm)	Thick-ness (mm)	Comments
spatulate manufacturing debitage	1	Terminal Late Archaic	Artiodactyla	humerus, distal diaphysis	62	8	8	Medial segment of debitage fragment from humerus diaphysis longitudinally split by grooving and snapping, with no evidence of additional shaping or subsequent use wear.
spatulate manufacturing debitage	1	Late Archaic	Artiodactyla	metapodial diaphysis	42.5	9	5	Segment of debitage fragment from metapodial diaphysis that has proximal groove/snap fracture that appears to have separated it from long bone tool blank. Fragment was longitudinally split by grooving and snapping, followed by longitudinal scraping to either begin shaping or to remove the periosteum.
spatulate manufacturing debitage	1	Middle Archaic	Artiodactyla	metapodial diaphysis	35	11	5	Medial segment of diaphysis with longitudinal grooving and snapping accompanied by longitudinal scraping to either begin shaping or to remove the periosteum.
spatulate manufacturing debitage	1	Middle Archaic	*Odocoileus* sp.	metatarsal, proximal epiphysis and diaphysis	44	14.5	8	Helically fractured fragment with partial transverse groove and deep cutmarks on proximal end.

Form	#	Cultural Context	Taxon	Element	Length (mm)	Width (mm)	Thick-ness (mm)	Comments
spatulate / perforator fragment	1	Terminal Late Archaic	Artiodactyla	metapodial diaphysis	83	14	6	Distal portion of long narrow tool with a very constricted distal end. Tip section is 3 mm in width, narrow oval in cross section, and has a rounded profile. Blank preparation by unknown method, followed by grinding to final shape. Bright invasive polish with rounding of high points is present. Micro-pitting common. Oblique smooth-edged striations are visible on lateral edges and on outer surface, consistent with use wear from wet hide.
spatulate / perforator fragment	1	Terminal Late Archaic	Artiodactyla	metapodial diaphysis	80	10	5	Distal portion of long narrow tool with a very constricted distal end. Tip section is 2 mm in width, oval in cross section, and has a rounded profile. Blank preparation by unknown method, followed by scraping and grinding to final shape. Four narrow rounded shallow use wear grooves are noted on one lateral edge, with transverse striations extending from tip to this point. Bright, invasive polish with rounding of high points. Transverse fine striations with smooth, rounded edges and micro-pitting are very common, consistent with use wear from dry hide.

Form	#	Cultural Context	Taxon	Element	Length (mm)	Width (mm)	Thick-ness (mm)	Comments
spatulate / perforator fragment	1	Terminal Late Archaic	*Ictalurus furcatus*	spine, pectoral	45	5	3	Distal portion of long narrow tool manufactured from modified catfish spine. Tool fragment is weathered, with several longitudinal desiccation cracks present. The narrow, constricted tip has a flattened oval cross section that is 1.25 mm wide. The tip has ground, slight micro-bevels and a small tear-out. Relatively bright, invasive polish is present and follows surface contours. Fine, smooth-edged, oblique striations are present on distal half of tool, consistent with use wear from dry hide.
spatulate or perforator preform fragment	1	Terminal Late Archaic	*Odocoileus* sp.	metatarsal diaphysis	74	16	10	Helically fractured fragment is carnivore-ravaged, but appears to be an early stage preform for a spatulate or perforator.
spatulate preform fragment	1	Terminal Late Archaic	Artiodactyla	metapodial diaphysis	35	11	9	Medio-distal segment of tool preform hat has been scraped to shape longitudinally, but not yet ground to final profile. Blank being prepared by unknown method, with no evidence of subsequent use wear.
spatulate preform fragment	1	Terminal Late Archaic	Artiodactyla	metapodial diaphysis	39	9	5	Proximo-lateral segment of tool preform that has been scraped to shape longitudinally, but not yet ground to final profile. Blank being

Form	#	Cultural Context	Taxon	Element	Length (mm)	Width (mm)	Thick-ness (mm)	Comments
								prepared by grooving and snapping, with longitudinal groove/snap fracture remnant present on dorsal surface and no evidence of subsequent use wear.
spatulate preform fragment	1	Terminal Late Archaic	*Odocoileus* sp.	metacarpal diaphysis	152	25	16	Fragmentary with a medial fragment missing and distal transverse break (post-deposition). Lateral edges are slightly smoothed. Blank being prepared by grooving and snapping, with longitudinal scraping, non-invasive polish, and numerous fine transverse striations of unknown origin evident.
spatulate refitting debitage fragment	1	Terminal Late Archaic	Artiodactyla	metapodial diaphysis	27	13	3.5	Proximal fragment of spatulate refitting debitage, with distal transverse groove/snap fracture and evidence of longitudinal scraping. Bright, invasive polish is suggestive of use wear from contact with dry hide.
turtle bone, utilized	1	Middle Archaic	*Trionyx* sp.	plastron, lateral	19.5	16.5	2.5	Weathered with limited delamination. Inner surface has faint incised cross-hatching. Bright, slightly invasive polish present on inner and outer surfaces. Numerous smooth-edged striations present oblique to or paralleling one axis of cross-hatching. Use wear consistent with contact by wet hide.

Form	#	Cultural Context	Taxon	Element	Length (mm)	Width (mm)	Thick-ness (mm)	Comments
wedge	1	Terminal Late Archaic	Artiodactyla	indeterminate long bone	30	11	4.5	Short, wide, sharply tapering tool with three step-wise shallow transverse grooves. Blank prepared by grooving and snapping, followed by scraping and grinding to final shape. Bright, patchy non-invasive polish and rounding of high points. Longitudinal striations evident. Use wear consistent with contact from wood.
wedge	1	No Provenienc e	*Odocoileus* sp.	phalange, 3^{rd}, proximal diaphysis	32	24	13	Short, wide, sharply tapering tool with three step-wise shallow transverse grooves. Slight tear-out of tip. Blank prepared by grooving and snapping, followed by cutting and scraping to final shape. Slightly invasive polish on high points, with some rounding of features. Use wear consistent with contact from wood.
woodworkin g tool, beveled and faceted	1	No Provenienc e	Artiodactyla	metatarsal diaphysis	94	14	7	Medio-distal portion of possible bark stripper tool made from spatulate manufacturing debitage. Moderately narrow, broken tip on longer narrow tool. Tip beveled and 7 mm wide. Blank prepared by grooving and snapping, with longitudinal scraping and grinding to final shape. Distal tip broken, but retains restricted discoloration and nine ground facets with evident

Form	#	Cultural Context	Taxon	Element	Length (mm)	Width (mm)	Thick-ness (mm)	Comments
								use wear. Very limited areas of medium bright polish on high points, very limited rounding of facet edges. Grouped smooth, narrow striations angle obliquely back from thicker lateral edge, including in discolored areas at tip. Use wear consistent with contact from wood.

Appendix 4

Table 7.1: Comparison of Time Units Used in Current Analysis to Regional Culture Chronology and Arenosa Shelter Stratigraphy

Nominal Cultural Stages Used in Analysis	Associated Regional Period Name	Approximate Dates (B.P.) at Arenosa Shelter	Associated Strata at Arenosa Shelter
Historic – Late Prehistoric	Historic – Infierno – Flecha	Modern – 1,320	Surface – 2
Terminal Late Archaic	Blue Hills – Flanders	1,320 – 2,300	3 – 9
Early Late Archaic	Cibola	3,150 – 2,300	10 – 11
Middle Archaic	San Felipe – Eagle Nest	3,200 – 5,500	12 – 32
Early Archaic	Viejo	8,400 – 5,500	37 – 33
Paleoindian	Oriente – Bonfire – Aurora	9,550 +	38 – 42 (and undefined stratum below 42 in Test Pit F)

Table 7.2: Degree of Element Fragmentation Represented by NISP:MNI/MNE Ratios (x:1).

Body Size Class	Ratio Historic – Late Prehistoric	Ratio Terminal Late Archaic	Ratio Late Archaic	Ratio Middle Archaic	Ratio Early Archaic	Ratio Paleo-indian
Fish (undetermined)	2	46	4.75	0	5	-
Fish (small)	1	2.05	1.33	-	-	-
Fish (small - medium)	2	5.33	3.7	1	-	-
Fish (medium)	1	3.06	1.17	1.16	-	-

Body Size Class	Ratio Historic – Late Prehistoric	Ratio Terminal Late Archaic	Ratio Late Archaic	Ratio Middle Archaic	Ratio Early Archaic	Ratio Paleo-indian
Fish (medium - large)	1.75	3.6	3.83	1	-	-
Fish (large)	1	1.97	1	1	-	-
Amphibian	-	1.5	2	-	-	-
Reptile (turtle)	1.25	3.4	2	1.33	-	-
Reptile (snake)	1	1.16	1	-	-	-
Bird (small – medium)	-	1.76	1.54	-	-	-
Bird (large)	-	1.45	1.09	1	-	-
Mammal (undetermined)	1	103.8	-	1.67	-	-
Mammal (small)	1.67	1.64	3.25	1.33	-	-
Mammal (medium, rabbit)	3.08	7.39	5.41	2.36	-	1
Mammal (medium, rodent)	1	1.2	1	1.5	-	-
Mammal (medium, carnivore)	1	1.66	1.06	2.43	1	-
Mammal (medium, undetermined)	1.5	-	3.75	1.75	3	-
Mammal (large)	2.18	9	3.56	3.6	2	6.31

Table 7.3: Feature 18 Lots and Their Contents.

Field Lot Number	Contents Based on Current Analysis
739	Anterior skull fragment with maxilla, premaxilla, and both tooth rows with P^4 – M^3 present, rib fragment and thoracic vertebra fragment resting against hard palate, contained in anterior matrix block.
740	Antero-dorsal skull fragment with right premaxilla.

Field Lot Number	Contents Based on Current Analysis
741	Right humerus diaphysis fragment, right distal radius fragment, thoracic vertebra fragment.
742	Right humerus diaphysis fragment with distal epiphysis.
744	Thoracic vertebra fragment, right $P^2 - P^3$ teeth.
745	Posterior skull fragment with left frontal and horn core, rib fragments, contained in posterior matrix block and originally identified only as rib fragments.

Table 7.4: Cranial Measurements from Feature 18 Bison Carcass Compared to Extinct and Modern North American *Bison* Taxa (Measurements from McDonald 1981:Tables 21, 25, and 29; Skinner and Kaisen 1947; and Wilson 1974, 1975).

Cranial Character Compared	Arenosa Shelter Feature 18	***Bison antiquus antiquus*** **(male)**	***Bison antiquus antiquus*** **(female)**	***Bison antiquus occidentalis*** **(male)**	***Bison antiquus occidentalis*** **(female)**	***Bison bison bison*** **(male)**	***Bison bison bison*** **(female)**
Upper M^1-M^3 alveolar length (mm)	98	105.6 ± 0.6	96.2 ± 2.4	97.3 ± 6.4	97.3 ± 2.9	90.6 ± 4.4	82 ± 8.4
Upper M^3 anterior cusp width (mm)	28.9	29.8 ± 0.2	28.9 ± 0.6	28.4 ± 0.7	24.3 ± 1.25	27.7 ± 0.3	26.0 ± ?
Greatest width of frontals at orbit (mm)	145 (observed for left side only)	338-400	289-341	311-394	276-310	289-356	248-291
Least width of frontals between orbit and horn cores (mm)	137 (observed for left side only)	276-352	238-303	261-348	214-262	237-318	198-233
Antero-postero diameter, horn core base (mm)	104 (observed left side only)	76-129	54-75	77-120	52-73	67-103	44-61

Cranial Character Compared	**Arenosa Shelter Feature 18**	***Bison antiquus antiquus* (male)**	***Bison antiquus antiquus* (female)**	***Bison antiquus occidentalis* (male)**	***Bison antiquus occidentalis* (female)**	***Bison bison bison* (male)**	***Bison bison bison* (female)**
Angle of divergence of horn cores, forward from sagittal	86°	72 - 86°	69-88°	63-83°	68-84°	58-79°	60-72°
Origin of horn core from frontals (supra/sub-horizontal)	subhorizontal	subhorizontal or horizontal	subhorizontal	horizontal or suprahorizonta l	horizontal	horizontal	horizontal

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